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ARCHEOLOGY.—*The "Neolithic" problem in the prehistory of India.*[1] EUGENE C. WORMAN, JR. (Communicated by GORDON R. WILLEY.)

For almost a hundred years, since interest in the prehistoric archeology of India first arose, archeologists have discussed the "Neolithic" cultures which existed in that country in ancient times. Archeological literature is full of references to "Neolithic" implements and peoples, and the accuracy of the use of the term has not been questioned. Yet, during the course of an extensive study of Indian prehistory, the writer has become impressed with the number of times the word "Neolithic" has been erroneously employed. He has therefore investigated the so-called "Neolithic" objects displayed in Indian museums and reported in literature in an attempt to discover just how many of them really merit the application of that term. The present paper constitutes a summary of the results of that investigation.

By definition, Neolithic culture is Stone Age culture. According to the writer's understanding of the matter, the primary trait that sets Neolithic culture apart from other Stone Age ones is that of intentional food-producing as opposed to mere food-gathering as a means of subsistence. This trait is found in the form of agriculture or animal husbandry or a combination of the two. Secondary traits, often but not always associated with Neolithic culture, are pottery and smoothed stone tools. These were apparently first produced by more or less sedentary peoples as a result of needs for storage and cooking vessels and for land-clearing or agricultural implements. A full Neolithic archeological site may therefore be characterized by the presence of domesticated plants or animals and by pottery and smoothed stone tools. The first three of these items are common to the highly developed material cultures of the present day, however, and they can not be taken by themselves as criteria of Neolithic culture. Neither can the presence of smoothed stone tools be universally accepted as an indication of the Stone Age date of a site. The absence of metal in an archeological complex containing the above-mentioned traits or stratigraphic evidence proving that the complex existed prior to the introduction of metal into the area is also necessary to the identification of a Neolithic site or culture.

The large majority of "Neolithic" artifacts collected in India consists of smoothed stone tools. Most of these are axes or adzes, but other types such as hammerstones, ring-stones, rubbing and grinding stones, and mortars are also represented. Some pottery and a few other objects are also classed as "Neolithic" because of their association with smoothed stone implements. Of all the material available, however, only smoothed stone axes and adzes have been collected and reported in sufficient numbers from enough parts of India to make a study of them practical. Thus, the writer has confined his study to these tools, believing that whatever information they produce will be corroborated by the evidence of other types of artifacts.

Most smoothed stone axes and adzes displayed in Indian museums and described in archeological literature were apparently

[1] Received February 9, 1949. This article is based upon nine months of archeological field work in India during 1938–39, as well as upon a bibliography of over 150 titles dealing specifically with Neolithic-like objects found in India and of an almost equal number of titles dealing with the Middle East and the Far East. A more detailed treatment of the same material is in the hands of the library of the Peabody Museum, Harvard University, Cambridge, Mass. As all bibliography used in this article antedates the partition of India in 1947, the term "India" as used herein includes the areas now comprising both India and Pakistan.

collected from the ground surface. They are without archeological context and are therefore of little value for cultural or chronological classification. Some have been found in the homes of modern Indian villagers, who regard them as thunderstones and who keep them for their imagined protective or curative properties (Fox, 1873; Walsh, 1904). A few have been excavated from datable historic sites where metal implements and epigraphic material were also found (Marshall, 1915). Some have been taken from supposedly prehistoric "Iron Age" urn burials, in which they were definitely associated with iron implements and pottery (Laffitte, 1932). In a few cases, smoothed stone celts have been collected from the surface of sites where the presence of considerable cultural debris, apparently lacking in metal objects, is visible but where excavation is needed to determine the date of the site.[2] In a very few instances, as at Bursahom, Kashmir State (DeTerra, 1942) smoothed stone celts have been uncovered in levels definitely underlying strata containing metal objects or other more or less datable, chronologically late artifacts. In no case, however, has any of these stone celts been recovered from a site in which it was positively associated with an archeological assemblage unquestionably representing a pre-metal, Stone Age, food-producing culture. There is therefore no Indian site or implement yet known to this writer that can surely be called Neolithic.

Nonetheless, it being unlikely that the thousands of smoothed stone artifacts in India are derived solely from Metal Age contexts, the writer made a typological examination of Indian smoothed stone axes and adzes in an effort to determine whether anything significant about them could be discovered regardless of their cultural affinities.

The writer plotted the sites at which Indian smoothed stone celts have been found. They occur as shown in Fig. 1, almost exclusively in Assam, Bengal, and in eastern, central, and southern India, south of the Ganges River flood plain, north of Pudukkottai State in Madras Presidency, and east of a line drawn in a south-southwesterly direction from Lucknow or Cawnpore in the United Provinces to Goa, the Portuguese territory on the southwest coast of India. Some celts are found also in parts of Kashmir State and the Punjab in north India, but the area in which they occur is not well defined (DeTerra, 1942; Vats, 1940). A very few celts or celtlike objects have been found in the Copper-Bronze Age sites of Mohenjo-daro in Sind and at Nal and Rana Ghundai (near Loralai), Baluchistan (Marshall, 1931; Mackay, 1937–38; Hargreaves, 1929; Ross, 1946). Aside from a few possible axes or adzes, reported but not thoroughly described by P. E. P. Deraniyagala (1943, 1945) as occurring in the Balangoda area of south-central Ceylon (approximately lat. 6°40′N., long. 80°45′E.), no celts have been found on that island.

The fact that the distribution of these celts is seen to be confined to the eastern half of India is probably significant. The presence or absence of celts in any given area apparently does not depend upon the presence or absence of suitable raw material for their manufacture. Neither can the rarity of recorded celt finds in northern India be explained by lack of exploration. One is therefore led to an interesting speculation as to the point of origin of most Indian "Neolithic" celts and their techniques of manufacture. This is that they were derived from the Far East rather than from the Middle East. At first glance this theory seems unlikely, in view of the fact that Neolithic culture is generally supposed to have originated in the highlands of the Middle East or Central Asia just northwest of India and to have spread from there throughout the Old World. Nevertheless, it can be supported to some extent by various kinds of evidence, of which only that supplied by stone tools is considered in detail below.

A preliminary survey of Indian celt types indicates that they were made by two basic techniques. Technique I seems to have included two main steps, chipping and smoothing, with sometimes an intermediate pecking step between the two. The chipping consisted of the removal of coarse flakes from one or both faces of a core or large flake

[2] E.g., at an unpublished site discovered by Father L. Faucheux, of Le Petit Séminaire, near Pondichéry, French India, about 1938. Also at Kapgal Hill, Bellary District, Madras Presidency, described in Foote, 1916, and visited by the author.

until (a) in the case of short, broad tools a radial chipping pattern had been formed, and (b) in the case of longer implements two parallel lines of flake scars meeting in a longitudinal ridge had been produced. The transverse section of a tool made by this technique is ovoid, lens-shaped, trapezoidal, or triangular. Smoothing, mainly around the cutting edge, followed the chipping, although pecking as a further shaping step was sometimes employed after the chipping and before the smoothing of the implement. Technique II consisted only of chipping and smoothing. The chipping included the removal of flakes from the sides as well as the faces of a core or large flake until an implement with almost flat faces and perpendicular sides had been formed. Further fine retouching then regularized the shape of the artifact. In some instances celts with almost geometrically squared corners and with perfectly rectangular transverse sections were made by chipping alone. The transverse sections of all tools made by this technique are roughly rectangular. Smoothing as used with this technique usually covers more than half the surface of the celt, and a high, shiny polish over most of its surface is common.

A subdivision of axes and adzes into types on the basis of shape, cross section, and technique of manufacture reveals the presence in India of 12 basic types, of which all but three are represented by both ax and adz forms. Three adz types have no counterparts among the axes examined by this writer. It need hardly be said that these ax and adz types are wholly arbitrary and that they represent only those implements that appear to the writer to be the most common or distinctive. All grades of variation in shape and section from one type to another may be found. In some cases, too, the identification of types has probably been made on the basis of incomplete data, hampered by the frequent lack of good illustrations. Nevertheless, these types are useful means of working with available information, and they are briefly described below.

The first four celt types form a group, all of them apparently being made by technique I. Smoothing is usually found only around the cutting edge; it rarely covers more than half the surface of the tool.

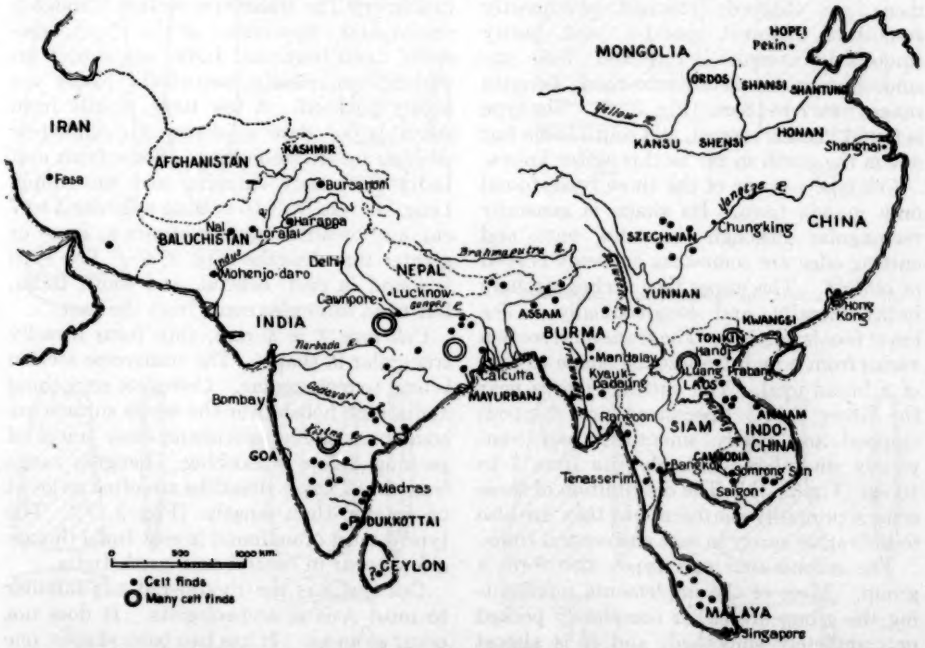

FIG. 1.—Map of celt finds in southern Asia. No attempt has been made to indicate the location of all celt finds in China.

Celt type 1 is rather rare. It is oval in shape. The transverse section is biconvex-lens shaped, oval, or trapezoidal. Specimens include chipped; chipped and partly smoothed; chipped, pecked, and partly smoothed; and completely smoothed forms. Lengths from butt to cutting edge range from 8 to 10 cm in specimens measured by the writer (Fig. 2, *1*). This celt type is found sporadically in east and south India.

Celt type 2, one of the two most common of all forms in India, is of elongated trapezoidal shape. The transverse section is planoconvex, biconvex, trapezoidal, or triangular in shape. Specimens include chipped; chipped and partially smoothed; chipped, pecked, and partially smoothed; completely pecked but unsmoothed; and completely smoothed varieties. Lengths range from 6 to 15 cm (Fig. 2, *2*). The type occurs commonly throughout north, east, central, and south India wherever celts of any kind are found.

Celt type 3 is the other of the two most common forms in India. It is of triangular shape. The transverse section is biconvex-lens shaped, oval, or almost circular. Specimens are chipped; chipped and partly smoothed; chipped, pecked, and partly smoothed; completely pecked but unsmoothed; or completely smoothed. Lengths range from 7 to 18 cm (Fig. 2, *3*). The type is found in east, central, and south India but not in the north so far as this writer knows.

Celt type 4 is one of the three types found only in adz form. Its shape is generally rectangular although the sides, butt, and cutting edge are somewhat convexly curved in outline. The upper face arches strongly both laterally and longitudinally. The lower face is flattish. The transverse section varies from a high trapezoidal shape to that of a broad oval. The cutting edge is near the lower face. Specimens are chipped; chipped and partly smoothed; and completely smoothed. Lengths run from 7 to 10 cm (Fig. 2, *4*). The distribution of these celts is primarily southern, but they are also found rather rarely in east and central India.

The second four celt types also form a group. Most of the implements representing the group are either completely pecked or completely smoothed, and it is almost impossible in many cases to determine the method by which they were made. The point which seems to set this group apart from the others, however, is that celts in it appear to have been manufactured by both technique I and technique II. The writer has not separated them into 8 types and placed them with the first or the last group because of the frequent uncertainty as to the technique of manufacture.

Celt type 5 is distinguished by its very large size and very thick transverse section. Shapes vary from almost cylindrical or rectangular to triangular. Transverse sections are circular, broadly oval, or square. Most specimens are completely pecked or completely smoothed. Examples include chipped and pecked; chipped and partially smoothed; chipped, pecked and partially smoothed; completely pecked but unsmoothed; and completely smoothed varieties, however. Lengths range from 20 to 25 cm, and the implements are quite heavy (Fig. 2, *5*). The type is found mainly in east India, but it occurs in small numbers in central India and, even more rarely, in the south.

Celt type 6 is tiny in size and trapezoidal in shape. The transverse section is roughly rectangular. Specimens of this type, especially those from east India, are almost invariably completely smoothed. Many are highly polished. A few tools, mostly from south India, show evidence of chipping or pecking before smoothing. Some from east India show only chipping and smoothing. Lengths from butt to cutting edge are 4 to 7 cm, and breadths are sometimes as great or greater than lengths (Fig. 2, *6*). The type is found in east, central, and south India, but most examples come from the east.

Celt type 7 is a rare, tiny form broadly triangular in shape. The transverse section is oval to rectangular. Complete smoothing and a high polish over the whole surface are common. A few specimens show traces of pecking before smoothing. Lengths range from 4 to 7 cm. Breadths are often as great or greater than lengths (Fig. 2, *7*). The type is most often found in east India though a few occur in central and south India.

Celt type 8 is the shouldered adz familiar to most Asiatic archeologists. It does not occur as an ax. It has two basic shapes, one curvilinear, the other rectilinear, as shown

in Fig. 2, *8a*, *8b*. The transverse section is ovoid in curvilinear specimens, rectangular in rectilinear ones. Chipped and pecked; chipped and partially smoothed; and completely smoothed specimens occur. Lengths range from 6 to 14 cm. The distribution of the type is confined almost wholly to east India. Rivett-Carnac claims to have discovered one example in central India (Rivett-Carnac, 1883). Cammiade states that the type occurs rarely near the Godavari river mouth in southern India (Cammiade, 1924; Cammiade and Burkitt, 1930). The writer found an apparently unfinished specimen in northern Mysore State in 1939.

The last four celt types can be grouped together as were the preceding ones, the point of similarity being their common man-

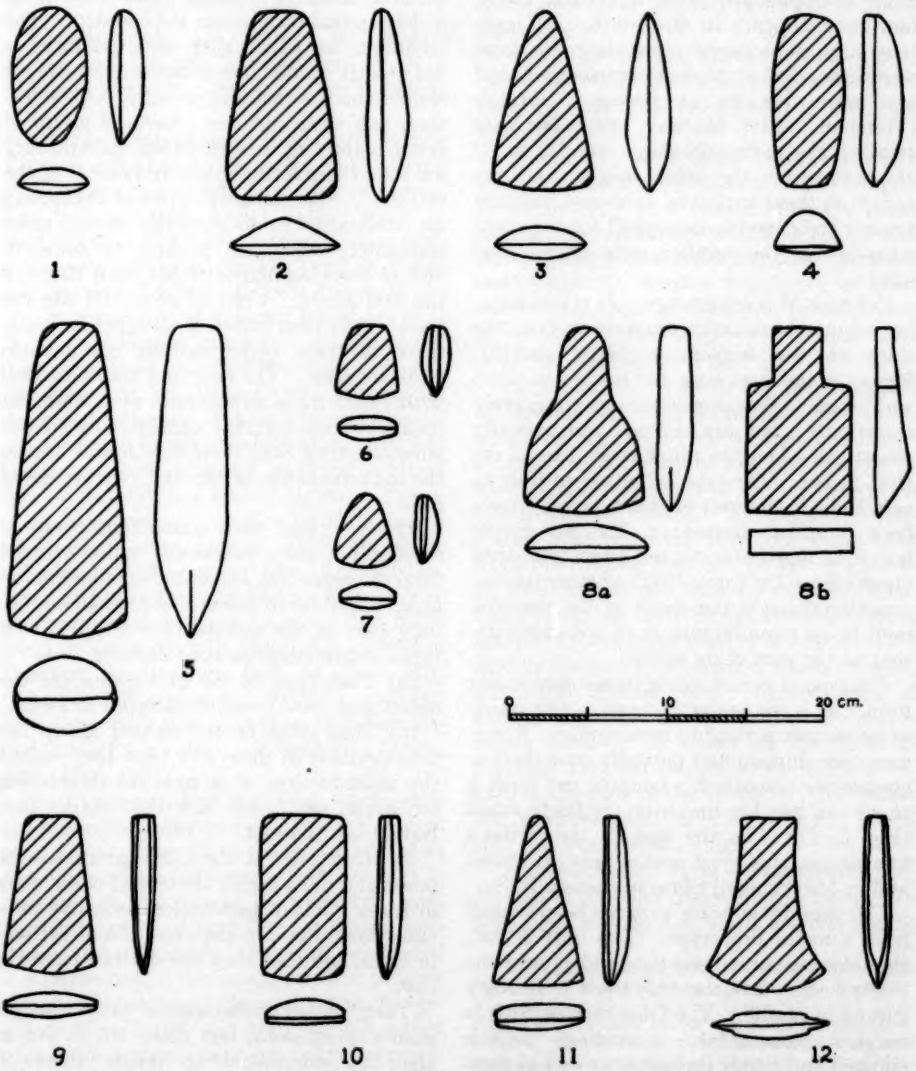

FIG. 2.—Indian celt types

ufacture by technique II. Smoothing usually covers more than half the surface of the implement and a high polish is frequent.

Celt type 9 is trapezoidal in shape and may be either broad or narrow. The transverse section is rectangular. Specimens are chipped and partially smoothed or completely smoothed. Lengths run from 8 to 18 cm (Fig. 2, *9*). The type occurs almost exclusively in east India where it is common. Some examples are found in central India, but none appears in the south. At least four large implements resembling this type were unearthed at Mohenjo-daro, Sind, and two were dug up at Harappa, Punjab (Marshall, 1931; Mackay, 1937–38; Vats 1940). The extremely large size (23 to 32 cm in length), the great weight, and the rarity of these artifacts, however, militate against their having been used for the same purposes as the smaller celts found elsewhere.

Celt type 10 is rather rare. It is rectangular in both shape and transverse section, the sides of the implement being parallel. Shapes range from long and narrow to short and broad. Most specimens are completely smoothed; a few are chipped and partially smoothed. Lengths range from 9 to 12 cm (Fig. 2, *10*). The type is limited entirely to east India. One celt of this type may have been found at Bursahom, Kashmir State, but it is impossible to tell from published illustrations (De Terra, 1942) whether the rectangular shape is the result of the material used in its manufacture or of conscious design on the part of its maker.

Celt type 11 is rare, being found only in adz form. It is triangular in shape. The transverse section is roughly rectangular. Specimens are chipped and partially smoothed or completely smoothed. Lengths run from 5 to 18 cm, but the majority are fairly small (Fig. 2, *11*). To the best of the writer's knowledge, this type occurs only in Orissa and in Mayurbhanj State in eastern India.

Celt type 12 appears to have been copied from a metal prototype. The butt is flat; the sides are curved and flare widely near the cutting edge; and the edge itself is strongly curved in profile. The transverse section is roughly rectangular. Specimens include chipped and partly smoothed as well as completely smoothed varieties. The majority of these implements are highly polished. Lengths run from 7 to 13 cm (Fig. 2, *12*). The distribution is confined to eastern India.

Upon studying the distribution of these three groups of celts one is immediately struck by the manner in which they substantiate a theory for the introduction of celts and celt-making techniques into India from the east rather than the west. Celts of group I contain those types not only the most frequently found in India but also those most widely spread throughout the country. The technique by which they were produced is not greatly refined, the forms of the tools are simple, and smoothing usually covers less than half their surfaces. Celts of group II occur mainly in eastern India, though they are found also in the south and center of the country. Specimens of types of this group are ordinarily more carefully made, more completely smoothed, pecked, or polished, and of more advanced forms than those of the first group. Celts of group III are the least widely distributed of all types in India, three of them being entirely confined to eastern India. The care and technical skill with which these implements were made bespeak for their makers a considerably greater stone-working skill than that found among the manufacturers of the first two groups of celts.

The fact that each succeeding group of celts is not only technically more evolved than the preceding one but also more limited in its distribution toward eastern India, the only part of the country where all 12 celt types occur, suggests the following:

(*a*) That celts of the first group are the oldest and most basic of all types in India.

(*b*) That celts of the second group are intermediate in date and that they reflect the introduction of a new manufacturing technique and some new celt shapes into India from the east.

(*c*) That celts of the third group are the latest and most highly developed of all types in India. Their distribution definitely indicates that they are the most recent arrivals in India and that they are derived from the east.

There is no archeological proof for the above conclusions, but there are as yet no clear-cut arguments to refute them. It therefore appears, if the above theory is true,

that stone implements from India should resemble those from eastern Asia more closely than those from the Middle East. There should also be some evidence to prove that the chronological dating of celt types suggested above is correct. Whether or not this is so can be demonstrated by a comparison of Indian and foreign celt types as described below.

THE MIDDLE EAST

Unfortunately, an attempt to compare Indian and Middle Eastern celt types is hindered from the outset by the following facts:

(*a*) The comparison of Indian and Middle Eastern celts has to be made, not between implements in immediately adjacent areas, but between tools found as far apart as central India and western Iran. Aside from a few celts excavated by De Terra in Kashmir, the only Indian celt finds known to the writer from west of central India are four large implements unearthed at Mohenjodaro, five celts found at Harappa, two celts discovered at Nal, Baluchistan, and one undescribed celt collected at the Rana Ghundai mound, near Loralai, Baluchistan. All but the last of these definitely occurred in Metal Age levels, and they are not typical either of a Neolithic culture complex or of the one in which they were found. The only stone celts known to the writer from Afghanistan, Russian Turkestan, and eastern Iran are two well-worked stone axes found by Sir Aurel Stein in low levels of a Metal Age mound at Bampur, southeastern Iran, at about latitude 27°15′N, longitude 60°30′E, and two celts from sites near Kanakan and Kamalabad in the Fasa Valley, southern Iran (Stein, 1934, 1936, 1937).

(*b*) In western Iran and Iraq, where celts are more often discovered, they are seldom well described or illustrated. In site after site where stone celts occur, they are said to display no typological development and, therefore, to be of no value for dating purposes. Consequently, they are considered less important to the excavator than pottery wares, decorative motifs, and other changeable culture traits, and they are left either undescribed or only very generally described. As a result of this custom of neglecting finds not useful for dating purposes, the writer is able to base his study of Middle Eastern celt types upon tools from only 20 sites.[3]

(*c*) At the majority of sites from which stone celts have been described, the earliest habitation layers containing these implements also contain copper or other metal objects indicating that the makers of the stone artifacts were already at the threshold of a Copper or Bronze Age. Most celts at these sites occur in levels definitely of Metal Age date.

(*d*) In the few sites where apparently pure Stone Age levels are found, neither the levels themselves nor the celts found in them are well described.

(*e*) Finally, while many Middle Eastern stone celts display evidence of the techniques by which they were manufactured, a great number are completely or almost completely smoothed and show no such traces. In these cases only the relative angularity of their shapes and cross sections can furnish clues as to their relationships with Indian celts made by techniques I and II.

Thus, one has to carry out a comparison of Indian and Middle Eastern celt types with the discouraging knowledge that all conclusions reached may be unsound because of the fragmentary nature of the evidence upon which they are based. Furthermore, difficulties arise from the fact that stone celts from the Middle East are no better criteria of Neolithic culture than they are in India, there being few truly Stone Age implements and no chronological scale of development of Middle Eastern types against which to check undatable Indian tools. Comparisons of Indian and Middle Eastern stone implements have to be made on the basis of typology and distribution alone, without regard to the date of the artifacts. Nevertheless, such comparisons bring out a few points that are worth mentioning.

In Palestine and Syria a considerable proportion of all celts discovered in both Neolithic and Bronze Age levels are chipped or

[3] Al 'Ubaid, Chagar Bazar, Jemdet Nasr, Kish, Nineveh, Nuzi, Tall Arpachiyah, Tell Hassuna, Tepe Gawra, and Uruk in Iraq; Sialk and Tepe Hissar in Iran; Ain Shems, Carchemish, Jedeideh, Jericho, and Teleilat Ghassul in Palestine and Syria; and Alaca Huyuk, Alishar Huyuk, and Mersin in Turkey.

chipped and slightly smoothed around the cutting edge. Other implements are more carefully made and are frequently completely smoothed. Most tools, however, whether slightly or completely smoothed, are of simple types similar to those of the Indian types 2 and 3. They appear to have been manufactured by a technique like that of the Indian technique I. Possibly not more than a quarter of all celts, most of which are completely smoothed, recall the angular Indian types 9 and 10 which are made by technique II. The Indian types 4 and 5 and the technically advanced types 8, 11, and 12 are completely absent from this area. In south Turkey and north Iraq, too, most celts are like the simple Indian types 2, 3, 6, and 7, though they are more often completely smoothed than they are in Palestine or Syria. Celt types 4, 8, 11, and 12 are also missing in this region. Pecking as a means of shaping a tool seems to occur but rarely in any of the above-mentioned areas.

In southern Iraq and Iran, where the basal levels of almost all sites already show traces of metal, stone celts as a whole are not so crudely made or so poorly finished as they are farther to the west and northwest. Here stone tools usually display a smooth finish, a greater tendency to angularity of form, and a greater variety of shape than they do to the westward. Only one-half to two-thirds of the celts here are similar to the simple Indian types 1, 2, 3, 6, and 7, and most of these artifacts are almost wholly smoothed. In addition, a much higher percentage (one-third to one-half) of the celt types here are similar to the Indian types 9, 10, and 11, and they, too, are ordinarily smoothed over the greater part of their surfaces. A very few type-8 celts of the round-shouldered variety found at Al 'Ubaid, Kish, and possibly Sialk constitute an exception to this general rule, being merely chipped or chipped and slightly smoothed. Celt types 4, 5, and 12 and the square-shouldered variety of 8 are missing. It is difficult to tell from published illustrations what part was played by pecking in the manufacture of any of the above celt types.

The impression gained from a comparison of both Stone Age and Metal Age stone celts from Palestine, Syria, south Turkey, and north Iraq with those from southern Iraq and Iran is that the implements from the former area are more primitive and of fewer types than those found in the latter region, regardless of the date of the levels in which they occur. In other words, the celts found to the westward are more often like the supposedly early Indian types made by technique I, while those to the eastward more frequently resemble the later Indian types made by technique II. Interestingly enough, the area where the simplest celt forms are found is exactly that in which almost all of the sites known to contain true or early Neolithic levels exist. The relatively early dates of the Neolithic influences in this area may therefore be reflected in the primitiveness of celt types as a whole throughout both the Neolithic and Metal Age periods. In addition, there is some evidence to indicate that the lower valleys of the Tigris and Euphrates Rivers were settled at a later date than the headwaters. It thus seems reasonable to suppose that persons inhabiting that region had more highly evolved techniques of celt manufacture than their predecessors to the north and west. The point cannot be proved, however, until further excavation has taken place.

The significance of the comparison of Indian and Middle Eastern stone celt types can be summed up in a few words as follows:

(*a*) The evidence, such as it is, suggests that the earliest Neolithic sites in the Middle East are north and west of the Tigris-Euphrates River basins and that the most ancient sites closer to India are of very late Neolithic or Metal Age date. There is no evidence to suggest that the earliest celts in India were brought into that country from regions immediately to the westward.

(*b*) The closest resemblances between Indian and Middle Eastern celt forms are between those types such as 2, 3, 6, 7, 9, and 10, which are commonly found throughout the world. The absence in the whole Middle East of specifically limited types such as the square-shouldered variety of type 8 and types 4 and 12 argue for a general rather than a specific cultural connection between the two areas. This contention is further borne out by the fact that painted pottery, which occurs widely throughout the Middle East in association with stone celts does not often occur in India east of the Indus River basin in prehistoric times.

(*c*) There is a slight suggestion in the Middle East that typologically cruder celts are earlier in date than better finished ones, just as was presumed to be the case in India. Theoretically, this seems perfectly reasonable. Actually, it has not yet been stratigraphically proved.

Simple though these conclusions may be, they do not contradict the expectations aroused by a study of stone celts in India. Rather, they support the theory of an eastern origin for the "Neolithic" techniques of stone-working in India. One may therefore turn to a comparison of Indian and Far Eastern celt types with the hope that it will be more enlightening than the one just completed. Fortunately, this hope appears to be justified though the evidence supporting it comes from regions somewhat removed from eastern India.

THE FAR EAST

Assam and Burma.—In Assam and Burma, as in peninsular India, the great majority of known Neolithic-like stone celts are unassociated finds picked up from the ground surface or purchased from local villagers. Of the few that have been recovered *in situ* most are isolated celts dug up from shallow depths during house-building, road-making, or ditching operations (Brown, 1917; Cockburn, 1879; Hutton, 1926). The writer knows of only one celt, found by Drs. De Terra and Movius near Kyaukpadaung, Burma, which occurred *in situ* in positive association with other objects such as waste flakes and small chipped stone scrapers, points, and cores (De Terra and Movius, 1943). Assamese and Burmese celts, therefore, are no better criteria of Neolithic culture than are Indian ones.

Most celts in Assam and Burma have been collected from (*a*) the Khasi and Naga Hills in Assam, (*b*) the hills on either side of the Irrawaddy River Valley in southern Burma, and (*c*) the hills along the Burmese seacoast from Arakan in the west to Tavoy, Mergui, and Tenasserim in the south. They are apparently not found in the flat lands of the large river flood plains, and only a very few have been discovered in the relatively unexplored highlands of central and northern Burma. Because of the paucity of archaeological exploration in this part of the world, however, it is not certain to what extent this distribution is the true one or not. It may represent only those areas in which settlement by Europeans is thickest.

Typologically, celts of types 1, 2, 3, 5, 6, 7, 8, and 9 have been found in Assam and types 1, 2, 3, 6, 8, 9, and 10 in Burma. The only types not found in any part of the area are 4, 11, and 12, all of which are rare in India. As all three of these types are clearly present in nearby regions of India and in Indo-China and Malaya, their absence in Assam and Burma may be a matter of spotty collecting. The distribution of celt types in Assam and Burma is such that no one type or group of types can geographically be separated from the others. Thus, there is no indication of the relative dates at which these celt types were introduced. This situation is that which might be expected if Assam and Burma were the corridor through which celt-making techniques entered India.

Little else can be said about this area, but as there is no apparent gap in celt distribution between India proper and Assam and Burma, it seems reasonable to suppose that future archeological excavations in the latter regions will uncover the remains of cultures much like those of eastern India.

Siam.—Siam is even more of a terra incognita to the prehistoric archeologist than are Assam and Burma. The only archeological excavations known to the writer to have taken place in prehistoric sites there are those made by Fritz Sarasin in a few caves in north and south Siam. These were reported in 1933 (Sarasin, 1933). In these caves Sarasin found a culture sequence which was represented at the top of the deposits by bricks and pottery of relatively modern date. Under these lay potsherds decorated with cord-marked or stamped designs reminiscent of late prehistoric ones from Indo-China. The lowest layer of the deposits contained chipped stone implements, animal bones, and mollusk shells. The artifacts, which included axes, points, and scrapers, were said to resemble Hoabinhian ones from Indo-China (to be described below).

In addition to these excavated remains a few surface finds of celts have been made at Chong, Surat, Petjaburi, and Betong in

south and peninsular Siam and near Nom Pladuk on the Bangkok-Moulmein railway.[4] These include nicely finished celts of types 8 and 9 and a beaked adze of a type found in Malaya and Indonesia. Other smoothed stone tools reported by Kerr and Seidenfaden[5] as found in north and east Siam are not described in any literature available to the writer.

The stratigraphy and implement types of the excavated cave sites, as well as the typology of the surface finds in Siam, are much like those of Indo-China and Malaya. While little of significance can be said about them, they lend credence to the supposition that the Stone Age cultures of Siam were related to those of the countries round about.

Indo-China.—The key to the late Stone Age culture problems of the whole of southeast Asia is found in Indo-China. Here one no longer has to deal with isolated surface finds but with a large number of excavated sites in which apparently pure, though undatable, Stone Age culture complexes exist. The majority of sites occur in caves and rock shelters near Hoabinh and in the Bacsonian limestone massif in Tonkin province. Scores of these sites have been found to contain shallow, unstratified earth deposits, seldom more than a meter deep, in which remains of a single, homogeneous culture phase occur. A few cave and shelter sites contain deposits up to 4 meters deep, in which clear-cut geologic layers are lacking but in which several successive culture phases are apparently represented. In addition to the caves and rock shelters in Tonkin and elsewhere, a number of open air kitchen middens have been excavated along the coast of Annam and in the interior of Cambodia. These middens are sometimes several meters deep, but most of them, unfortunately, enclose elements of only one typologically rather mixed phase of culture.

The stone implements from the deeper cave and shelter sites display a typological evolution from crude, chipped or chipped and slightly smoothed stone tools found at the base of the deposits to well-shaped, finely smoothed stone artifacts at the top. Pottery occurs only in the upper levels with the more advanced stone tools. On the basis of the apparent cultural evolution represented at these few deep sites, French archeologists have constructed a chronological scheme of cultural development into which material from the single-period sites has been fitted. The scheme is primarily typological, but it is supported by a certain amount of stratigraphic evidence which lends it some degree of accuracy.

According to this scheme, the earliest post-Pleistocene archeological remains in Indo-China are those of the Hoabinhian complex, found in the region near Hoabinh, Tonkin (Colani, 1927). They have been divided into three periods—early, middle, and late.

In the early period, the stone implement industry is based on rounded river pebbles, roughly chipped at one end or on one face only. Types include pebble choppers, oval shaped implements, pyramidal tools, a few chipped short-axes or "haches courtes," points, and scrapers. Large numbers of fresh-water mollusk shells and infrequent bones of large land mammals, including *Elephas* and *Rhinoceros*, testify to the diet of the people. Neolithic traits are conspicuously absent.

In the middle period, stone implements are of slightly better workmanship. Choppers, oval-shaped tools, axes, pyramids, discoid implements, smoothed pebble celts apparently made by grinding down one end of a natural pebble to a cutting edge, chipped and slightly smoothed celts, chipped short-axes, points, scrapers, and polishing stones occur. The celts resemble the Indian types 1 and 2 in appearance and manufacture. Bone points and spatulae are found in small numbers. Mollusk shells and some large mammal bones are found. The Neolithic trait of stone-smoothing appears here for the first time.

In the late period, the stone industry continues a trend toward finer and smaller implements. A few choppers, ovoid tools, discoid implements, chipped and partially smoothed celts, short-axes, points, large rectangular and ovoid scrapers, crescentic scrapers derived from short-axes, and a large

[4] COLLINGS, 1936; EVANS, 1926; SARASIN, 1933; and material collected by H. R. van Heekeren while he was serving as a Japanese prisoner during the recent war.

[5] KERR, A., and SEIDENFADEN, E., *Siam, nature and industry*: 60. Bangkok, 1930. Mentioned in Sarasin, 1933.

number of small triangular, ovoid, or variously shaped points and scrapers occur. The small points and scrapers are said to be the most numerous of all tool types and to represent a distinct departure from the earlier large tool tradition. They are said to be the most striking feature of the Late Hoabinhian stone industry. A few bone blades or spatulae still exist, and a few smoothed bone axes are found. Pottery occurs for the first time. The usual mollusk shells and wild animal bones are present. There is still no trace of agriculture or of domesticated animals.

The Bacsonian culture complex which developed in Tonkin province not far to the northeast of the Hoabinhian one, was in many ways similar to the latter (Mansuy, 1909, 1924, 1925a, 1925b; Mansuy and Colani, 1925). It, too, has been divided into early, middle, and late phases, the implements in which display a gradual evolution from crudely chipped to finely smoothed types.

In the early period, the majority of stone implements are chipped into irregular shapes similar to those found amongst Hoabinhian tools. Ovoid artifacts, discoid tools, small axes or points, chipped and partially smoothed celts, large chipped scrapers of elongated ovoid form, pestles or grinding stones, hammerstones, and elongated narrow pebbles with parallel rows of grooves along their sides are found. Celts are like the Indian type 1 specimens. Fresh-water mollusk shells and infrequent bones of Bovidae, Suidae, and Cervidae occur with the implements. Of typical Neolithic traits, stone-smoothing is rare, and traces of agriculture, animal husbandry, and pottery are absent.

In the middle period, implement complexes show an evolution away from the oval chipped, Hoabinhian-like tools toward triangular and trapezoidal celts with smoothed cutting edges. The stone industry includes celts of the Indian types 1, 2, 3, 6, and possibly 7, chipped oval tools, large ovoid scrapers, smaller chipped scrapers or retouchers, pebble polishing stones, elongated smoothed pestles, discoid rubbing stones, stationary mortars, and the elongated grooved pebbles of unknown use. A few bone awls are found. Some shells, presumably shaped for ornamental purposes, also occur. Smoothing of the cutting edges of stone implements is now common. Pottery appears for the first time in this culture sequence and is either plain or cord-marked. Positive traces of agriculture and animal husbandry are lacking. The usual mollusk shells and animal bones are present.

In the late period the stone celts are usually more regular in shape, and they are smoothed over a greater part of their total surface. Celts of the Indian types 2, 6, 8, and 9 occur. Well-smoothed stone rings or bracelets of types also found in parts of Burma and east India also occur. The Neolithic trait of stone-smoothing is common. Pottery is now found in some quantity. It is decorated with incised, cord-marked, and mat-marked designs. There is still no mention in archeological reports of domesticated grains or animals, but the bones of cattle, buffalo, pig, deer, rhinoceros, elephant, bear, primates, and fresh-water turtles are now common for the first time. This fauna seems to represent a change from a shellfish and vegetable food-gathering economy to a more advanced hunting one although the usual shellfish still appear in large numbers.

The cultural remains from the large shell midden at Somrong Sen, south of Lake Tonle Sap, Cambodia, are generally considered to be among the latest Stone Age ones in Indo-China (Anonymous, 1891; Cartailhac, 1890; Mansuy, 1902, 1923; Moura, 1882; Noulet, 1879). Unfortunately, however, the precise nature of the complex or complexes present here can not be determined (*a*) because much of the mound has been disturbed by local villagers who dig out the shells for burning into lime and (*b*) because no record has been kept of the depths from which individual artifacts have been excavated by archeologists. According to Mansuy, who made the most extensive excavations, the surface layer of the mound contained large numbers of potsherds of wares almost identical to those made by the modern villagers living there. Below this level, Mansuy noted only a confused mass of clayey earth, ash beds, hearths, mollusk shells, animal and human bones, and artifacts (Mansuy, 1902, 1923). The statements of Ludovic Jammes, who described alternating layers of shell and alluvial mud and who claimed to have excavated bronze objects from the upper portions of the mid-

den, have been effectively discredited by Louis Finot (Finot, 1928). Mansuy dug large parts of the site without finding a single article of metal, and earlier visitors who collected metal objects at Somrong Sen apparently bought all of them from the modern villagers living there. For the moment, then, one can only assume that the bulk of the midden contained nothing but Stone Age artifacts.

The stone industry from the midden includes celts of the Indian types 2 or 10, 4, 6, 8, 9, and 11, narrow chisels, a few hammerstones, a few polishing stones, small stone discs or cylinders, and stone rings or bracelets similar to those from Tonkin, Burma, and east India. In addition to the stone tools, the Somrong Sen midden contained bone arrowheads, points, chisels or burins, fishhooks, and miscellaneous items; shell rings or bracelets, discs, pendants, and beads; a few marine shells used as ornaments; and a considerable quantity of plain or decorated handmade pottery. Decorative motifs consisted of incised, indented, punctate, carved, and applique designs in straight or curved line geometric figures. Cord-marking was rare and mat-marking absent so far as this writer could determine. Domestic animals may be represented for the first time in Indo-China, a dog just like the modern Annamese species being found in the faunal assemblage here. Other animals include cattle, deer, pig, rhinoceros, elephant, (?) tiger, reptiles, and birds. Traces of agriculture are still lacking insofar as reported finds are concerned.

Mansuy also obtained from the villagers at the site of Somrong Sen a triangular arrowhead with tang and wings, a cylindrical shank or stem from some unidentified object, a rough chisel, a large fishhook, a simple ring, and four bells, all of which were made of either copper or bronze (Mansuy, 1902, 1923). Not one of these articles was actually excavated by him from the mound. J. Moura, who sent a collection of three rings, seven ring fragments, an ax, two arrowheads, a hook, and two plaques to France in 1877, also obtained his material from the modern villagers rather than from excavations (Moura, 1882; Noulet, 1879). Ludovic Jammes, who stated that he examined Somrong Sen and 14 or 15 other sites in the vicinity, claims to have dug pits in four of the sites and to have discovered objects of bronze associated with human bones. He sent to France a collection of five axes, some chisels, a spearhead, a knife, some rings, a hook, and some bells, all either of copper or bronze (Cartailhac, 1890; Finot, 1928). These artifacts are apparently of varying date, and it is not known from what site each one of them was excavated. It is therefore impossible to point to a single object of this collection as having been found positively at Somrong Sen. Since all kinds of remains of widely divergent dates occur near Lake Tonle Sap, it can not be stated with certainty that any metal artifacts obtained from the villagers at Somrong Sen definitely come from that mound rather than from some other. Some of the copper and bronze implements reputedly from Somrong Sen resemble artifacts which were in use in southeast Asia up to or after the beginning of the Christian Era. If they actually come from the upper levels of the midden, both they and the stone implements immediately underlying them have to be considered to be of relatively late date.

Stratigraphically, the sequence of early, middle, and late phases within the Hoabinhian and Bacsonian culture complexes as described above is fairly well fixed by data from a few deep sites. The relative chronological position of the Hoabinhian, Bacsonian, and Somrong Sen complexes as a whole, however, is not so clearly demonstrable. It is based on the similarity of artifact types at various stages of cultural development. The Mid-Hoabinhian and Early Bacsonian phases are equated because of the presence in them for the first time of smoothed stone celts. The Late Hoabinhian and Mid-Bacsonian phases contain the first pottery. The Late Bacsonian and Somrong Sen phases contain celt types not previously found, and pottery occurs in both of these phases in much greater quantity than before. The sequence of cultures according to this correlation is therefore somewhat as follows:

	Late Bacsonian	Somrong
Late Hoabinhian	Mid-Bacsonian	Sen
Mid-Hoabinhian	Early Bacsonian	.....
Early Hoabinhian	.....	.....

If this sequence can tentatively be ac-

cepted, the significance of the Indo-Chinese finds with regard to those discovered in India is obvious. The Mid-Hoabinhian and Early Bacsonian culture phases contain celt similar to the Indian ones of types 1 and 2, here stratigraphically shown to be the earliest in Indo-China just as they were claimed on typological grounds to be the earliest in India. The Late Hoabinhian and Mid-Bacsonian archeological complexes contain celts of types 1, 2, 3, 6, and possibly 7. The likenesses of Indian and Indo-Chinese celts are now shown by four or five rather than two types. At this same time, similarities of chipped as well as smoothed stone implements in India and Indo-China become obvious. In collections from Indian sites near the southern border of the Deccan,[6] the writer has found chipped ovoid and elongated choppers, bifacially chipped axes, chipped axes, chipped pyramids or discs, chipped short-axes, short-axes with smoothed cutting edges, crescentic scrapers of the type derived from the short-ax, large rectangular and ovoid scrapers, rough triangular points, flake blades, small points made of thin flakes, discoid and rectangular rubbing stones, hammerstones, and pestles, almost all of which would fit into a Late Hoabinhian or Mid-Bacsonian implement series. The celts found at these sites also include types not appearing prior to the Late Hoabinhian or Mid-Bacsonian periods. Late Bacsonian and Somrong Sen celts, presumably the latest found in Indo-China, include forms similar to the Indian types 2, 4, 6, 8, 9, 11, and possibly 10. Of these, at least two types are believed on typological grounds to be among the latest ones in India. There is therefore some stratigraphic proof from Indo-China that celts of types also found in India were introduced into the cultures of that area in the same chronological order as they were believed to have been introduced into India. This stratigraphic evidence supports that from Siam, Burma, and Assam where surface finds and some excavated sites suggest that cultural connections with India exist.

The only point of variance between the sequence postulated on typological grounds for India and that observed in excavated Indo-Chinese sites is the first appearance of the Indian celt types 4 and 8 in the latest Indo-Chinese archeological complexes. Typologically, they belong to the early and intermediate celt groups in India. The author cannot now determine what the true position of these types may be.

Of the four Indian celt types 5, 7, 10, and 12 not positively reported from excavated sites in Indo-China at least one has been collected there in surface finds. This is the celt type 12 that occurs in the area around Luang Prabang, Laos.

In spite of certain discrepancies and gaps in the evidence, the conclusion that the smoothed stone celts of Indo-China are related both typologically and chronologically to similar tools in India is hard to avoid. Material from actual excavations in Indo-China bears out in considerable detail the suggestions of relationship evoked from a study of fragmentary remains in Burma and Siam, and the few but important stratigraphic data seem to confirm points merely implied by finds in other countries. One may therefore turn to an examination of Stone Age discoveries in Malaya with the expectation that they will corroborate information already obtained from regions to the northward.

Malaya.—As was anticipated, recent excavations in the central and northern Malay States have uncovered Stone Age culture complexes of much the same type as those found in Indo-China.

In Kelantan, the lower layers of cave and rock shelter sites contain Hoabinhian-like choppers, ovoid implements chipped on one or both sides, and possibly short-axes (Noone, 1939; Tweedie, 1940). Pottery is absent. The intermediate layers of the same sites contain finer Hoabinhian-like oval implements, short-axes, scrapers, and small flake tools, together with chipped and partly smoothed celts made by the Indian Technique I and similar in shape to the Indian type 2. A few celts are chipped, pecked, and partially smoothed and have thick cross sections. These resemble the Indian celt type 5. Pottery is present but rare. The uppermost levels contain angular celts with rectangular cross sections, chipped and

[6] Especially in a collection made by the writer at Bellary, Madras Presidency, and in a collection made by the Archeological Department, Hyderabad State, Deccan, at Kotegal, Raichur District, Hyderabad.

smoothed over more than half their surface in a manner resembling that of the Indian Technique II. These are like the Indian celt type 9. In addition, beaked adzes and waisted axes, not found in India, appear. Black, dark brown, and reddish pottery of plain or cord-marked and incised varieties similar to those from Indo-China to Burma occur. Fresh-water mollusk shells and the bones of cattle, deer, pigs, bears, and primates come from these sites, but none of the animals is of a domesticated type and no evidence for the practice of agriculture is present.

In Perak, Kedah, Perlis, and Pahang, the same general sort of thing has been excavated from cave and shelter sites (Callenfels and Evans, 1928; Evans, 1928; Collings, 1936, 1937b, 1937c).

Surface finds in the north and central Malay States include celt types similar to the Indian types 1, 2, 5, 8, 10, and 12, some of which have not yet been found in excavations (Collings, 1936, 1937a; Winstedt, 1935).

Thus it appears that the celt types and cultural stratigraphy of Malaya are much the same as those from other parts of southeast Asia.

China.—On turning to China one finds the situation there a bit more complicated. North China is archeologically the best known portion of the country. Yet an examination of supposedly Neolithic finds from this region shows that few of them are derived from scientific excavations, that the majority of those few are imperfectly described, and that all of them come from sites dating from periods immediately preceding the introduction of metal. The presence in north China of earlier Neolithic peoples is postulated almost entirely on the basis of typological evidence.

In the now-arid regions of the Ordos, Mongolia, and western Manchuria a series of archeological complexes dominated by the presence of microliths has been discovered (Teilhard de Chardin and Pei, 1944). Unfortunately, these occur primarily at surface sites which defy exact dating.

In the loess regions of Kansu, Honan, Hopei, Shansi, and Shensi provinces in northern China, culture complexes referable to an Early Neolithic period are entirely lacking. Only a few surface finds of chipped stone tools suggest the presence there of early post-Palaeolithic peoples (Cheng Te-k'un, 1941, 1942; Teilhard de Chardin and Pei, 1944).

In northwest China, however, particularly in Kansu, a series of Late Stone Age and Early Metal Age archeological complexes have been described by J. G. Andersson (Andersson, 1925, 1943). These complexes are known primarily from painted pottery and stone objects. Using painted pottery as his main criterion, Andersson has divided the Kansu material into six groups, three representing "Neolithic" cultures and three illustrating Early Metal Age ones. The three "Neolithic" groups have been named Ch'i Chia, Pan Shan, and Ma Chang, after the type sites at which they were found. They are stated to have existed chronologically in the order given, but proof for the statement is not entirely satisfactory. Typologically, all the Stone Age remains are "Late Neolithic," but there is very little evidence to show to what date they actually did belong.

In the loess highlands of north-central China, Late Neolithic assemblages containing painted pottery similar to that in the Pan Shan one of Kansu have been found (Andersson, 1923, 1943). They are best represented at the site of Yang Shao Tsun in Honan Province, where finds of grain, ox, dog, and pig bones, pottery, and smoothed stone tools testify that a Neolithic economy was practiced at the time.

Farther eastward in the Great Plain region along the lower reaches of the Hwang Ho and Yangtze Kiang in northeast China, remains of another widespread Late Neolithic culture complex called Lungshan have been discovered (Liang Ssu-yung, 1940; Beath, 1941; Wu, 1938; Archeologia Sinica, 1934). The stone implements of this complex resemble those of the Pan Shan and Yang Shao ones farther west, but the pottery is somewhat different. Its two most distinctive wares are an unpainted, fine, wheelmade, dark gray to black ware and an unpainted, coarse, handmade, brown to dark gray ware usually covered with coarse textile marking.

The exact chronological relationship between the western highland and the eastern lowland complexes is somewhat uncertain.

Both may have been contemporary for a considerable period of time. Evidence available at such sites as Hou-kang, Yang Shao Tsun, and Anyang in Honan and at Lungshan (Ch'eng-tzu-yai) in Shantung indicates that both immediately precede the date of the introduction of metal into China.

Since the precise relationships and relative chronologies of these north Chinese Neolithic complexes are still uncertain, smoothed stone implements taken from them cannot yield much but typological information. Artifacts from Late Neolithic and Metal Age sites or levels show little difference, and none shows any stratigraphically demonstrable evolution in type. Among the presumably Late Neolithic stone implements of north China, however, are types like the Indian ones 2, 6, 8, and 9, which also occur in the sites of India, Indo-China, and Malaya. In addition, there are pecked celts similar to pecked specimens of the Indian types 2 and 3, which are lacking in Indo-China and Malaya. Also present are celts of type 5, which is missing in Indo-China but found on the surface in Malaya, and celts of type 10, which to date occurs only on the surface in southeast Asia. Other north Chinese celt forms not found in India include perforated celts of trapezoidal, rectangular, or square shapes, perforated stone battleaxes, and a waisted celt or hoe somewhat like that from Malaya.

There are several points of interest displayed by these north Chinese celts. One is that most of them are of types like the Indian ones believed to belong to intermediate or late dates. As the Chinese celts are of Late Neolithic date, this may be significant from the point of view of chronology. Another is that among the Late Neolithic north Chinese celts are varieties showing pecking, a technique of manufacture very rarely found in southeast Asia. This suggests that the pecking technique, and possibly certain celt forms connected with it, may have been introduced into India directly from China without reaching southeast Asia in large numbers. If this is true, the date of introduction was prior to that of the entry of the finely made celts of types 9 to 12, since pecked celts occur far beyond the limits of the former types. A third point is that celts of the rectangular type 10 also come from north China. The writer has found very few examples of this type in southeast Asia. A final point is that while the similarity of certain north Chinese celt forms with those in India suggests a cultural relationship of some kind, the fact that many north Chinese celts do not occur in India indicates that by Late Neolithic times the cultural connections were general rather than specific. Unfortunately, for lack of data it is impossible to determine how close the relationship may have been in earlier periods. Nevertheless, it does appear that the cultures of China, rather than southeast Asia, were responsible for the origin of the Indian celt types 5 and 10, regardless of the date at which they were first made.

Turning to south China one finds that the part of the country south of the Tsinling mountains is relatively unexplored and that few sites of any kind have been excavated there.

In the province of Kwangsi, near the borders of Indo-China, excavated caves have yielded archaeological material somewhat like that from Hoabinhian sites in Indo-China (Pei, 1935; Teilhard de Chardin and Pei, 1944; Teilhard de Chardin, Young, Pei, Chang, 1935). No Bacsonian or later type of complex has yet appeared here.

Outside of Kwangsi practically all study of Stone Age artifacts has to be done on a typological basis. The only place in which this has been done in detail is in the province of Szechwan. The stone implements from this province, most of them surface finds, have been exhaustively studied by Cheng Te-k'un and have been compared by him with stone tools from other parts of eastern Asia. The complete results of Cheng Te-k'un's work are contained in an unpublished doctoral thesis now in the archives of Harvard University. A summary of them appears elsewhere (Cheng Te-k'un, 1941, 1942, 1947).

After making a typological study something like the present one, Cheng Te-k'un suggests that there were four periods of stone implement evolution in Szechwan. These were (*a*) a Mesolithic period during which only chipped stone tools were used, (*b*) an Early Neolithic period characterized by implements partially smoothed near the cutting edge, (*c*) a Late Neolithic period in which the art of pecking stone was intro-

duced, and (*d*) an Aeneolithic period during which implements were almost completely smoothed. Cheng Te-k'un also states that 34 of 41 chipped stone types, 6 of 11 chipped and partially smoothed ones, and 14 of 17 completely smoothed ones are the same in both Szechwan and Indo-China. He concludes, aside from the lack of pecked tools in Indo-China, that the major classes of stone artifacts probably appeared in Szechwan in the same chronological order as they are believed to have done in Indo-China. This may or may not be true, and proof or disproof of the statement will require years of future excavation. Nonetheless, it appears perfectly logical, in view of the increasing amount of evidence from Kwangsi and the whole of southeast Asia, that implements similar in so many respects to those of southeast Asia should have had a similar history.

If Cheng Te-k'un is correct, the stone industries of Szechwan should also be like those of India, where stonework seems to have evolved very nearly as in Indo-China. Thus, through the agency of the few stratified Indo-Chinese sites, one may equate the Late Stone Age culture complexes of Szechwan with those of India as follows:

Szechwan	*Indo-China*	*India*
Aeneolithic	Late Bacsonian, Somrong Sen	Late "Neolithic"
Late Neolithic	Late Hoabinhian, Mid-Bacsonian	Middle "Neolithic"
Early Neolithic	Mid-Hoabinhian, Early Bacsonian	Early "Neolithic"
Mesolithic	Early Hoabinhian	....

According to this scheme, Cheng Te-k'un's independent dating of pecked implements in Szechwan to an intermediate period would correspond to the present writer's dating of similar tools to a Middle "Neolithic" period. These tools, neither the earliest nor the latest of "Neolithic" celt types, may some day appear in southeast Asian complexes of about Mid-Bacsonian type. When found in Late Neolithic north Chinese horizons, they may be considered as survivals of earlier types. At present, pecked tools show a closer relationship between India and China at a certain period in prehistory than they do between either India or China and southeast Asia.

Specific information regarding the point of origin of the Indian celt types 7 and 12, which have not been positively identified from southeast Asian or north Chinese excavated remains, is not easy to find in south China. Celts of type 7 have been collected in some numbers in Yunnan in association with other characteristically Indian types such as 2, 3, 5, 8, and 9 (Anderson, 1871; Brown, 1909, 1914). They may therefore have originated somewhere in southwest China or Burma and have been brought to India at an intermediate date along with the small type 6 and its apparent contemporaries 5 and 8. No information about the origin of celt type 12 is forthcoming from south China at all.

With regard to China as a whole, it seems that during the early post-Pleistocene period the stone industries of the Ordos, Mongolia, and Manchuria differed considerably from those of Kwangsi in southernmost China. It would further appear that at a slightly later date the implement assemblages of southern China, southeast Asia, and the eastern half of India were very much alike. To what extent they also resembled those of northern China is not known until shortly prior to the date of the first known metal there. Specifically, however, there is some reason to believe that cultural connections involving the use of celt types 5, 7, and 10 were closer between China and India than between India and any other region.

DATING

The dates when smoothed stone implements were extensively used in India and eastern Asia are difficult to determine with the information now at hand, and only the most general statements regarding them can be made. As is already well known, stone celts were utilized well into the Metal Age in many parts of western, southern, and eastern Asia. In some instances, the periods of such use are established by historically datable archeological material. The latest dates at which celts were employed by purely Stone Age peoples, on the other hand, are harder to ascertain. The dates of their earliest use in Asia cannot be estimated with any degree of certainty.

In India, metal was apparently first employed in the Copper-Bronze Age cultures of the Indus River Valley between about 3000 and 1500 B.C. There is no indication that cultures of this type extended far east of

the Indus basin at any time prior to 1500 B.C. Neither is any other kind of early Metal Age culture known to have existed in any part of eastern, central, or southern India. Therefore, the first Metal Age peoples to penetrate deeply into India were presumably the Indo-Aryan immigrants from the west, who established settlements in the Ganges river floodplain by about 1000 B.C. If this be true, Stone Age cultures could have existed in much of north India until the beginning of the first millennium B.C. Stone Age peoples may also have lived in southern India until approximately the fourth century B.C., when the first major contacts between the Indo-Aryans of the north and the aborigines of the south were apparently made.

In China, historical records of an advanced metal-using people are fairly well established as far back as the beginning of the Chou dynasty in 1122 B.C. The traditional dates of the next earlier Chinese dynasty, that of Shang, are recorded in later Chinese literature as 1766 to 1122 B.C. The only known archeological site of this period is that of Anyang, a capital city of the late Shang rulers in Honan province, which can be dated roughly from 1400 to 1100 B.C. Excavations at this site have uncovered many "oracle bones" (or bones used in divination) on which traces of a written script have been found. The script lists the names of sufficient kings of the Shang dynasty to prove that records of its traditional chronological position preceding that of Chou are essentially correct and that the dates of 1400 to 1100 B.C. given in later literature for the Shang occupation of Anyang are reasonably accurate. Excavations have also shown that the people of this period were well acquainted with bronze, though not with iron, and that they manufactured beautiful vessels and other objects of very superior workmanship. The date of the use of metal in north China may therefore be pushed back to about 1400 B.C. on fairly reliable evidence.

The technical excellence of the Shang bronzes and the strictly local character of their forms and decoration suggest either that the art of metal-working had undergone a long development in China prior to 1400 B.C. or that it had been introduced into that country in a highly evolved state and adapted to local use with considerable rapidity. Unfortunately, no early Shang remains dating from the period between 1700 and 1400 B.C. have been excavated, and there is no way of knowing whether or not the founders of the dynasty were responsible for the introduction of bronze-working into China. On the basis of present information, therefore, the date of the first use of metal in north China cannot be put earlier than 1400 B.C. Thus, Late Neolithic cultures may have lasted in that area until about the middle of the second millennium B.C.

There is no evidence of metal-working in south China prior to the beginning of the Metal Age in the north. One may therefore assume that Stone Age cultures existed in south China until some time after 1400 B.C.

The earliest sites in southeast Asia which contain metal objects date from about the fourth or third centuries B.C. to the first century A.D., during part of which time Indo-China was under the control of the Chinese Han Empire. At approximately the same time, iron may have been introduced to the coastal portions of southeast Asia from India. By these dates, both bronze and iron were regularly employed in north China and India, and most peoples of those countries had long since passed out of the Stone Age. Thus, metal was apparently brought to southeast Asia considerably later than it was to the countries to the north and west. Stone tools may therefore have been extensively utilized in the marginal regions of Indo-China, Siam, and Malaya until the beginning of the Christian era or later.

The next earlier dates which it is possible to estimate are those of the first rectangular-sectioned stone celts made by the Indian technique II. Information regarding them is derived almost wholly from north China, however, and it can not be considered as trustworthy as that given above.

A number of archeologists have noted the similarities between designs painted on Late Neolithic pottery in northwest China and those found on pottery in Early Metal Age sites in the Middle East. In addition, they have pointed out a few striking likenesses in the form, color, and texture of some Lungshan plain wares and certain Metal Age Middle Eastern ones. On the basis of these

data, it has been claimed that Late Neolithic north Chinese cultures are both related to and descended from the Middle Eastern ones in which the above characteristics appear. Whether or not the points of similarity constitute valid evidence of cultural relationship has not yet been fully decided. Nevertheless, it is true that painting on pottery is primarily a Middle Eastern rather than a Far Eastern trait, and it may be that the Late Neolithic complexes of north China represent the easternmost expansion of a widespread series of Middle Eastern ones. If this is true, the earliest dates of the north Chinese painted pottery and gray-black pottery complexes cannot well be before 3000 B.C., the time at which their Middle Eastern parallels appeared. Indeed, these complexes may well be considerably later, and they may have lasted till Shang times.

The Late Neolithic cultures of north China are the earliest more or less datable ones in eastern Asia in which celts of the types 9 through 12 appear. If they were derived from the west, their influence at least in the form of stone-working techniques probably spread eastward and southward until it reached southeast Asia and India. There is no way of discovering exactly how long it may have taken for this to occur. However, if the art of metal-working took almost 1500 years to reach southeast Asia from the points of its introduction into India and China, it may have taken an equal period of time for the Late Neolithic stone implement types to penetrate into Indo-China and Malaya. This is pure speculation, of course. Still, since the spread of metal was undoubtedly as rapid as that of stone implements, it may not be far from the truth. It is therefore possible that sites in India and southeastern Asia in which celts of types 9 to 12 are found should not be dated earlier than 1500 B.C. at the earliest. The limited distribution of rectangular-sectioned celts in India, coupled with the fact that these types frequently occur only in the topmost few inches of archeological sites or upon the ground surface throughout southeast Asia, strongly suggests that they were late arrivals in those regions.

The dating of the earliest smoothed stone implements in eastern Asia is also something of a problem. If the late Neolithic culture complexes of north China were related to Bronze Age ones in the Middle East, and if they spread into China from the west, there is a possibility that they were superimposed upon a series of still earlier Neolithic complexes already existing in eastern Asia. The following data suggest that something like this actually happened. The earliest archeological sites throughout the Far East in which Neolithic traits have been found are characterized not by painted pottery of west Asiatic types but by unpainted, cord-marked, textile marked, mat-marked, or incised and indented wares. These wares occur from Lake Baikal in eastern Siberia to Indonesia and from eastern China to Kashmir State in north India. They may also be related to the cord-marked and comb-marked potteries which made their way into central and northern Europe with Neolithic peoples. Wares of these types are present in Kashmir State, Burma, southern Siam, Indo-China and Malaya. Similar pottery also occurs in considerable quantity even with the painted and gray-black wares of Kansu, Yang Shao, and Lungshan in north China. It is completely foreign to the Neolithic and Metal Age cultures of the Middle East and the Mediterranean world. Along with other objects found only in the Neolithic and quasi-Neolithic sites of eastern Asia, it serves to point out the basic differences in cultural tradition between the eastern and western portions of the continent. It therefore seems that any late, west Asiatic Neolithic cultural influences reaching China actually did intrude into a large east Asian area in which at least one of the four basic Neolithic traits was commonly represented. Because of the paucity of Early Neolithic finds in northern China, one cannot make the same statement with regard to smoothed stone tools. Still, in south China, southeast Asia, and India a number of stone celt types have a wider or earlier distribution than those found in the Late Neolithic north Chinese complexes. It is therefore possible that these apparently early celt types were also in use in north China before Late Neolithic times.

The wide distribution of the east Asiatic potteries and early types of stone tools far beyond the limits reached by the western painted pottery and rectangular-sectioned celts indicates that the origin and earliest expansion of the cultures utilizing the former

should be placed before 3000 B.C. It may be that they date from as early as 5000 or 4000 B.C. though proof for any such assumption is still lacking. If they did spread into northwest China from west or central Asian centers of origin, however, and if the 1500-year time lag postulated in previous cases may again be used here, the earliest Neolithic traits may not have reached peninsular India and southeast Asia till 3500 or 2500 B.C. Granted, this last is a time when copper and bronze were already known throughout the Middle East and the Indus valley in India. Nevertheless, the distribution of stone celts mainly in the eastern half of India, together with the lack of proof that Neolithic traits spread into the peninsula from the west, strongly indicates that these celts could not easily have reached India at a very early date. The dates mentioned may therefore be reasonably accurate. They are certainly no later than those of the first Neolithic remains in northern and western Europe.

In summary, then, the earliest Neolithic-like stone tools probably appeared in India not earlier than 3500 or 2500 B.C. They remained in general use in northeastern India at least until the introduction of the late celt types 9 through 12 at about 1500 B.C. In peninsular India they may have been employed till the fourth century B.C. Celt types 9 to 12, first made in India around 1500 B.C., were apparently still spreading westward when they were supplanted by metal implements brought into the Ganges river basin by the Indo-Aryan immigrants from the west at approximately 1000 B.C. They never reached the southern part of the country.

CONCLUSIONS

As a result of the above study, one can draw the following conclusions:

(*a*) In India itself there is no positive archeological proof for the existence of Neolithic peoples at any time before or after the use of metal was introduced into that country.

(*b*) On the basis of their typology and distribution, Indian smoothed stone celts of "Neolithic" type, regardless of their cultural affiliations, appear to be derived from the eastward. Chronologically, they seem to have been introduced into the country at different dates.

(*c*) A typological comparison of Indian and Far Eastern celt types corroborates the above postulate of typological relationships and supports the theory that certain Indian types are earlier in date than others.

(*d*) Since most southeast Asian stone celts which are similar to Indian ones occur in archeological associations with genuine Stone Age characteristics, most Indian celts probably also belong to Stone Age cultures very much like those of southeast Asia.

(*e*) If the above is true, the eastern half of India belonged to a fairly large south and east Asiatic area throughout which the evolution of post-Pleistocene prehistoric cultures was apparently more or less similar. In the early periods, this area seems to have included much of India, Burma, southeast Asia, and southern China. In the later ones, it was apparently confined in the west to the easternmost provinces of India but expanded in the east to include parts of north as well as south China.

Other evidence supplied by geography, zoology, botany, and archeology further supports the theory of long-standing cultural relationship in the area embracing India, southeast Asia, and south China, but it cannot be considered here.

(*f*) Unfortunately, in spite of the strong suggestion that many Indian "Neolithic" artifacts really belonged to Stone Age cultures, there is still no indication from any part of southern and eastern Asia that these cultures were Neolithic ones. Archeological excavation and publication in India and the Far East has, for the most part, been so casual that no records of domesticated plants or animals exist outside of north China even though such remains may actually have occurred at excavated sites. In spite of the argument that the wet climates of monsoon Asia do not favor the preservation of plant remains, it is not beyond the bounds of possibility that careful excavation will uncover them in the dry earth of caves and rock shelters. Neither is it impossible that a proper examination and identification of excavated animal bones will produce the proof that some of the species were domesticated. In fact, there seems a definite chance that evidence for food-producing could be found.

Confirmation of the nature of Indian and other Far Eastern celt-using cultures, however, depends primarily upon the archeology of the future rather than the past. Typological studies such as the present one, based on incomplete information, are of value only in suggesting the existence of cultural movements or relationships. They cannot in themselves be accepted as final, and this writer in no way considers his conclusions proven. It is therefore to be hoped that intelligently planned programs of archeological investigation will be instituted or continued in India and elsewhere in order that the problems of prehistory in those regions may be solved.

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PALEONTOLOGY.—Two new genera of brachiopods from the Henryhouse formation (Silurian) of Oklahoma.[1]

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The writer has recently made a study of the brachiopods from the Henryhouse formation that has resulted in the recognition of two new genera. The complete faunal study will be published in about a year, but since Dr. Alwyn Williams wishes to refer to one of these genera in a paper soon to be forthcoming, it seems advisable at this time to publish a description of the new genera and their genotypes.

The specimens studied are located at the U. S. National Museum and were made available through the courtesy of Dr. G. A. Cooper and Dr. A. R. Loeblich. The writer also wishes to acknowledge the help of Dr. Cooper who gave suggestions and criticisms throughout this study.

Lissostrophia, n. gen.

Description.—Shells belonging to this genus are small with a subtriangular to subcircular outline; the hinge line is straight and forms the greatest width of the shell. In lateral profile it is strongly concavo-convex with the brachial and pedicle valves fairly close together; the curvature of both valves is uniform, there being no fold or sulcus. The pedicle beak is small and the palintrope of both valves is well developed, that of the pedicle being slightly wider than the brachial. The surface of both valves is completely smooth except that some shells may show faint, concentric growth lines.

In the pedicle interior the diductor scars are moderately deep, elongated subparallel to one another, and separated by an elevated platform to which the adductors were presumably attached. The hinge-plate is denticulate for one-half to two-thirds its length; the delthyrium usually appears as a rather shallow notch in this plate and in some specimens it is represented by only a very slight indentation.

The brachial interior is marked by a conspicuous elongate cardinal process which is directed posteriorly at right angles to the hinge line. The posterior half of this cardinal process is divided into two lobes which are subparallel to one another. Two thick ridges extend out from the base of the cardinal process in an anterio-lateral direction. In addition, there are two relatively broad median ridges which extend from about the center of the valve almost to the base of the cardinal process. At the posterior end these are separated by a low median platform which extends in an anterior direction until it attains approximately two-thirds the distance from beak to border. In the central portion these two median ridges are separated by a valley but at their posterior end they are again separated from one another by a low ridge which is a continuation of base of the cardinal process. The brachial hinge plate is strongly denticulate for a part of its length.

Genotype, *Lissostrophia cooperi*, n. sp.

Discussion.—This genus is somewhat similar to *Pholidostrophia* (Hall and Clark, 1892, p. 287) in size, shape, and lack of ornamentation, but it is not nacreous. Internally it differs from that genus in that the diductor scars of the pedicle valve are narrow and subparallel, whereas in *Pholidostrophia* they are broader and semi-flabellate. In the brachial interior the cardinal process of *Lissostrophia* is more erect and extends farther beyond the hinge line than does that of *Pholidostrophia;* furthermore, the two median ridges are much better developed in *Lissostrophia.*

This genus differs from *Brachyprion* (Shaler 1865, p. 63; Caster 1939, p. 31, 33) and related genera in its complete lack of radial ornamentation. Also in the pedicle interior of *Brachyprion* the muscle scars are flabellate.

Lissostrophia cooperi, n. sp.

Description.—The shell is small and subcircular in outline. Its hinge line is straight with the lateral extremities produced into points. The width is about equal to the length with some specimens being slightly wider than long and others slightly longer than wide. It is deeply concavo-convex with the brachial valve rather closely following the pedicle to produce a shallow living chamber. The surface is completely smooth except for faint, irregularly spaced growth lines. A specimen of average size will measure about 6 mm. wide, 5.5 mm. long, and 3 mm. deep.

Discussion.—This is probably the species that Reeds (1911, p. 263) called *Pholidostrophia* sp.

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This species is named for Dr. G. A. Cooper.

Holotype, U.S.N.M. no. 115194.

Distribution.—This is a common species in the Henryhouse. Holotype from the Cen. NE¼SW¼ sec. 10, T. 2 N., R.6 E., Pontotoc County, Okla.

Nanospira, n. gen.

Description.—The only known species of this genus is the genotype, which has an extremely small, subcircular shell. It has a strongly convex pedicle valve and a brachial valve which is flattish to slightly concave. The pedicle valve has a smooth, even curvature and a small, pointed beak. There is a brachial sinus which is narrow and distinct on the posterior portion of the valve becoming broad towards the anterior end. The exterior of both valves is completely smooth except for concentric growth lines.

In the pedicle interior the teeth are prominent and attached directly to the wall of the valve. There is a median septum or platform which extends for about one-half the length of the valve and which is V-shaped in cross section. This begins as a low ridge at the posterior end but becomes increasingly broader and higher towards the central part of the valve; its anterior end is slightly excavated and the sides are produced forward for a short distance as low ridges.

The brachidium of this genus is rather unusual and the writer is indebted to Dr. G. A. Cooper for preparing specimens to show this structure. The spire is abbreviated, consisting of less than one volution with the apices medially directed. The jugum is unusual in that each of its branches comes off from the anterior portion of the spires; these continue posteriorly as separate structures which are outside of and parallel to the main branches of the spires. Near the posterior end of the valve they cross over the descending lamellae and turn forward before uniting. The spire appears to be strongly spinose.

This genus has a smooth exterior like that of *Glassia* (Davidson 1881, p. 11). The spires of *Nanospira* are directed as they are in *Glassia* but have many less coils; the jugum is different, originating much further forward than in *Glassia*. Also *Glassia* appears to lack the strong median platform which is present in the pedicle valve of *Nanospira*. *Protozyga* (Hall and Clarke 1894, p. 151) has a simple spire like that of *Nanospira* but differs in the nature of its jugum and in having dental plates in the pedicle valve. *Cyclospira* (Hall and Clarke 1894, p. 146) differs in its biconvex profile and strong ventral sulcus. The jugum of *Cyclospira* is unknown.

Genotype, *Nanospira parvula*, n. sp.

Nanospira parvula, n. sp.

Description.—This species has a very small shell with the width about equal to the length and a short hinge line. It has a strongly convex pedicle valve and a weakly convex to weakly concave brachial valve. The pedicle beak is small and strongly curved over the dorsal but not in conjunction with it; along the mid-line of the pedicle valve the curvature is sharp with the shell sloping uniformly away from here to the lateral and anterior margins. There is a brachial sulcus which is narrow at the posterior end but which becomes broad at the anterior end; on the posterior half of the brachial valve where this sulcus is narrow and confined to the mid-line this valve retains a slight convexity but toward the anterior end where it broadens out so that it occupies almost the entire width of the shell this part of the valve becomes slightly concave. The surface is completely smooth except for growth lines, these being best developed on the anterior half of the shell. A specimen of average size measures about 3.5 mm. long, 3.5 mm. wide and 2 mm. thick. The brachial and pedicle interiors have already been described.

Discussion.—*N. parvula* is the only known representative of this genus and has been identified only from the Henryhouse formation.

Holotype, U.S.N.M. no. 115195.

Distribution.—Specimens of this species are common in the Henryhouse. Holotype from Chimneyhill Creek in Cen. E½SE¼SW¼, sec. 4, T. 2 N., R. 6 E., Pontotoc County, Okla.

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ENTOMOLOGY.—*The status of the genus* Mymar *Curtis* (Hymenoptera: Mymaridae).[1] A. B. GAHAN, U. S. Bureau of Entomology and Plant Quarantine. (Communicated by C. F. W. MUESEBECK.)

The genus *Mymar* has been discussed by Hincks (Proc. Roy. Ent. Soc. London **13:** 38. 1944) and by Soyka (Zentbl. für Gesamtgeb. Ent., Jahrg. 1 (5–6): 180. 1946). Unfortunately I cannot agree with either author.

In the list of type species of the genera of chalcid-flies by Gahan and Fagan (U. S. Nat. Mus. Bull. 124: 92. 1923), *Mymar* Curtis and *Anaphes* Haliday were stated to be isogenotypic, both having as genotype *Ichneumon punctum* Shaw. *Anaphes*, being the later proposed name, was indicated as a synonym of *Mymar*. The reasons for this conclusion were not there discussed, as they were considered to be rather self-evident to anyone who cared to investigate. Neither Hincks nor Soyka agrees with these conclusions, nor do they agree with each other. It therefore seems desirable to state the facts upon which this synonymy was based. These are as follows:

The generic name *Mymar* was first published without description by John Curtis in 1829 (Guide to Brit. Ins.: 112) and credited by him to Haliday. Eighteen specific names were included under the generic name, most of these being manuscript names of Curtis, Walker, Haliday, and Stephens, but names of three previously described and valid species were also included, viz, *Ichneumon punctum* Shaw, *I. ovulorum* Linnaeus, and *I. atomos* Linnaeus. This publication of the generic name *Mymar* in connection with valid species established the name and made eligible for type of the genus any one of the three described species mentioned. None of the 15 manuscript species included can be considered eligible for designation as type. Among the latter was the Walker manuscript name *pulchellus*.

In 1832 Curtis (Brit. Ent. **9:** 411) published a description of *Mymar*, naming as type of the genus *Ichneumon punctum* Shaw. Although naming *punctum* as the genotype, Curtis figured and described only *Mymar pulchellus*, Walker manuscript, and at the end of the generic description stated that "the dissections and descriptions are taken from the species figured." It is evident from the generic description, however, that Curtis took care to make it broad enough to include *punctum* as well as *pulchellus*.

In 1833 Haliday (Ent. Mag. **1:** 349) redescribed *Mymar* as his own genus but cited Curtis's previous references. Haliday included in *Mymar* the single species *pulchellus*. At the same time (p. 346) he erected the genus *Anaphes* with two included species, one being *Ichneumon punctum* Shaw and the other *Anaphes fuscipennis* Haliday. He made no reference to genotypes.

In 1840 Westwood (Introd. Mod. Class. Ins. **2:** Synop.: 78), ignoring the previous designation by Curtis of *Ichneumon punctum* Shaw as type of the genus *Mymar*, named *Mymar pulchellus* Curtis as the type of *Mymar* and *Ichneumon punctum* as the type of *Anaphes*.

Ashmead in 1904 (Mem. Carnegie Mus. **1:** 363) cited *Mymar pulchellus* Curtis as type of *Mymar* but named *Anaphes fuscipennis* Haliday as type of *Anaphes*. Since *Ichneumon punctum* had already been designated as type of *Anaphes*, Ashmead's designation must be ignored.

From the foregoing statements the following facts are apparent.

1. *Mymar*, as a generic name, must be credited to Curtis and must date from 1829, since it was there published with inclusion of valid species.

2. *Ichneumon punctum* Shaw must be accepted as the genotype of *Mymar*, since it was one of the originally included species and was legitimately designated as the genotype by Curtis in 1832, thus having priority over the designation of *pulchellus* by Westwood in 1840.

3. *Ichneumon punctum* Shaw was originally included in *Anaphes* and was legitimately chosen as type of that genus by Westwood.

Soyka's conclusions likewise are un-

[1] Received March 15, 1949.

tenable, at least in part. This author proposes the new generic name *Oglobiniella* and names as genotype *Mymar pulchellus* Curtis. If *pulchellus* is congeneric with *wollastonii*, as I believe it to be, then *Oglobliniella* Soyka is a synonym of *Mymarilla* Westwood. If the two species should prove not to be congeneric (and on the basis of Westwood's figures there is ground for doubt), then *Oglobliniella* should stand. Until this question can be cleared up, I prefer to use *Mymarilla* with *Oglobliniella* as a synonym. Soyka's action in attempting to name for the genus *Mymar* Curtis an entirely new genotype (viz, *Mymar ferrierei* Soyka) is entirely unacceptable since the species was not an originally included one and the genus already had a legitimately fixed type.

Since *Ichneumon punctum* is the type species of both *Mymar* Curtis and *Anaphes* Haliday, it follows that the name *Anaphes* must fall as a synonym of *Mymar*. This is unfortunate since it necessitates the realignment of the generic and specific combinations for a considerable number of species, but I can see no way to avoid this except by a complete disregard of the Rules of the International Commission on Nomenclature. The generic name *Mymar* must be used in the sense of *Anaphes* Haliday and authors, and all the species now known and catalogued in *Anaphes* should henceforth take the name *Mymar*. At the same time all the species heretofore placed in the genus *Mymar* must be known by a different generic name, and for this purpose *Mymarilla* Westwood (Trans. Linn. Soc. London, Zool., **1** (ser. 2): 585, footnote. 1878), with *M. wollastonii* Westwood as its genotype is resurrected from the synomymy. It is possible that *Flabrinus* Rondani (Bul. Soc. Ent. Ital. **9:** 180. 1877) may be the same as *Mymarilla*, but it seems extremely doubtful that this genus can ever be satisfactorily identified.

The conclusions by Hincks in the paper already mentioned are contrary to those arrived at in the foregoing remarks. In my opinion they do not conform to the International Rules of Nomenclature, and hence are untenable.

MAMMALOGY.—*A new name for the meadow mouse* Microtus roberti occidentalis *Turov.*[1] DONALD F. HOFFMEISTER, University of Illinois (Communicated by HERBERT FRIEDMANN.)

When Prof. S. S. Turov described *Microtus roberti occidentalis* in 1928, he undoubtedly was unaware of the earlier (1848) description by Peale of *Arvicola* [= *Microtus*] *occidentalis*. Peale's name is now regarded as a synonym of *Microtus townsendii townsendii* (Bachman, 1839). Efforts have been made over a period of years to contact Professor Turov and bring this fact to his attention for rectification. In the absence of any word from Turov or any known action that he has taken, it seems advisable now to make the required changes.

Turov regarded the species *roberti* as belonging to the genus *Microtus*. Some other workers have regarded *roberti* as a member of a distinct genus *Chionomys*. However, Miller (Ann. Mag. Nat. Hist. **8:** 97. 1908) and Argyropulo (Zeitschr. für Saugetierk. **8:** 182. 1933) presented rather conclusive evidence that *Chionomys* should be regarded as a subgenus of *Microtus*. In reviewing the problem, Ellerman goes farther by regarding *Chionomys* a synonym of the subgenus *Microtus* and places *Microtus roberti* in a species-group other than that of the type (*Microtus nivalis*) of *Chionomys* (see Ellerman, *Families and genera of living rodents*, British Mus. Nat. Hist., **2:** 592. 1941).

The subspecies *occidentalis* of Turov is here regarded as a member of the genus *Microtus* and its name thus is preoccupied by *Microtus occidentalis* Peale. This subspecies may now be known as:

Microtus roberti turovi, n. name

Microtus roberti occidentalis Turov, Arb. Nord-Kaukasischen Assoc. Wiss. Inst., no. 44–45: 27. 1928; *nec Arvicola* [= *Microtus*] *occidentalis* Peale, U.S. Expl. Exped., Mamm. and Ornith.: 45. 1848 (type from Puget Sound, Wash.).

[1] Received March 17, 1949.

Type.—No. 21K., ♀, August 25, 1926, on the shore of Lake Kardivach [in rhododendron overgrowth], Mzimite River, Caucasus [U.S.S.R.] (translated from Turov, p. 27).

Turov, on page 29, *op. cit.*, adds that three "other examples [were] caught 2–3 versts below Kardivach on the banks of the Mzimite River in rocky places overgrown with silver fir forest."

PROCEEDINGS OF THE ACADEMY

51ST ANNUAL MEETING

The 51st Annual Meeting, concurrently with the 361st meeting of the Academy, was held as a dinner meeting in the ballroom of the Hotel 2400, January 22, 1949, at 5:30 P.M., with the President, FREDERICK D. ROSSINI, presiding.

Following the dinner, the guest speaker, W. Alfred Noyes, talked on *International cooperation in science*. Greetings to the Academy were extended by FRED E. WRIGHT, home secretary of the National Academy of Sciences, and S. S. NEGUS, president of the Virginia Academy of Science.

The minutes of the 50th Annual Meeting were approved as published in the JOURNAL **38:** 213–222. 1948.

The reports of several officers, standing committees, special committees, and committees of auditors and tellers were read and accepted. The pertinent reports are recorded at the end of the minutes.

After acceptance of the report of the Committee of Tellers, the President declared the following duly elected to the given offices:

FRANK H. H. ROBERTS, Jr., *President*
FRANCIS B. SILSBEE, *President-Elect*
FRANK M. SETZLER, *Secretary*
HOWARD S. RAPPLEYE, *Treasurer*
WILLIAM F. FOSHAG and C. LEWIS GAZIN, *Board of Managers to January, 1952.*

The Secretary presented for the Affiliated Societies their nominations for Vice-Presidents of the Academy as follows:

Philosophical Society of Washington—FRANCIS E. JOHNSTON
Anthropological Society of Washington—WILLIAM N. FENTON
Biological Society of Washington—JOHN W. ALDRICH
Chemical Society of Washington—FREDERICK D. ROSSINI
Entomological Society of Washington—C. F. W. MUESEBECK
National Geographic Society—ALEXANDER WETMORE
Geological Society of Washington—JOHN B. REESIDE, JR.
Medical Society of the District of Columbia—FREDERICK O. COE
Columbia Historical Society—GILBERT GROSVENOR
Botanical Society of Washington—FREEMAN A. WEISS
Washington Section of the Society of American Foresters—WILLIAM A. DAYTON
Washington Society of Engineers—CLIFFORD A. BETTS
Washington Section of the American Institute of Electrical Engineers—FRANCIS B. SILSBEE
Washington Section of the American Society of Mechanical Engineers—RICHARD S. DILL
Helminthological Society of Washington—AUREL O. FOSTER
Washington Branch of the Society of American Bacteriologists—MARGARET PITTMAN
Washington Post of the Society of American Military Engineers—HENRY W. HEMPLE
Washington Section of the Institute of Radio Engineers—HERBERT G. DORSEY
Washington Section of the American Society of Civil Engineers—OWEN B. FRENCH

The Secretary was instructed by the members present to cast a unanimous ballot for these nominees.

The chairman of the General Committee on Awards for Scientific Achievement, KARL F. HERZFELDT, announced the recipients of these awards for 1948 as follows:

In the Biological Sciences, ROBERT J. HUEBNER, National Institutes of Health, in recognition of contributions to our knowledge of the transmission of certain rickettsial diseases.

In the Engineering Sciences, MAXWELL K. GOLDSTEIN, Office of Naval Research, in recognition of distinguished research and development in the field of electronic engineering.

In the Physical Sciences, J. A. VAN ALLEN, Applied Physics Laboratory of Johns Hopkins University, in recognition of his work in nuclear physics and cosmic rays.

The retiring President, FREDERICK D. ROSSINI, gave a short talk and introduced the incoming President, FRANK H. H. ROBERTS, Jr. Dr. Roberts adjourned the meeting at 9:00 P.M.

REPORT OF THE SECRETARY

During the Academy year, January 15, 1948, to January 22, 1949, one person was elected to honorary membership and 73 to regular membership, including 70 to resident and 3 to nonresident. Of these, 55 resident and 2 nonresident qualified for membership. Fourteen resident members and one nonresident member elected to membership in the preceding Academy year qualified during the present Academy year just ending. The new members were distributed among the various sciences as follows: 13 in chemistry, 11 in medicine, 10 in physics, 6 each in botany and entomology, 4 each in engineering and mathematics, 3 each in geophysics and plant pathology, 2 each in biochemistry, electrical engineering, paleontology, and zoology, and 1 each in biology, endocrinology, ethnology, physiology, and science history.

Seven resident and three nonresident members, having retired from the gainful practice of their professions, were placed on the retired list of members to enjoy all the privileges of active membership without further payment of dues. Nine resident members and one nonresident member resigned in good standing. Four resident and six nonresident members were dropped for nonpayment of dues.

The deaths of the following members were reported to the Secretary:

WILLIAM R. MAXON, Washington, D. C., on February 25, 1948.
NELSON H. DARTON, WASHINGTON, D. C., on February 28, 1948.
ALBERT F. WOODS, Hyattsville, Md., on April 12, 1948.
ALBERT K. FISHER, Washington, D. C., on June 12, 1948.
OSCAR E. MEINZER, Washington, D. C., on June 14, 1948.
HAROLD W. MURRAY, Washington, D. C., on June 15, 1948.
HARRY DIAMOND, Washington, D. C., on June 21, 1948.
FRANÇOIS E. MATTHES, El Cerrito, Calif., on June 21, 1948.
ERNEST C. ANDREWS, Sydney, Australia, on July 1, 1948.
RICHARD C. TOLMAN, Pasadena, Calif., on September 5, 1948.
LOUIS COHEN, Arlington, Va., on September 28, 1948.
JOSEPH A. AMBLER, New Orleans, La., on October 6, 1948.
HORACE T. HERRICK, Washington, D. C., on October 7, 1948.
WILLIAM H. EMMONS, Minneapolis, Minn., on November 5, 1948.

ERNEST C. ANDREWS and ALBERT K. FISHER were honorary members, and NELSON H. DARTON ALBERT F. WOODS, and ALBERT K. FISHER were original members.

On January 22, 1949, the status of membership was as follows:

	Regular	*Retired*	*Honorary*	*Patron*	*Total*
Resident	498	55	2	0	555
Nonresident	155	30	14	0	199
Total	653	85	16	0	754

The net changes in membership during the past year are as follows:

	Regular	*Retired*	*Honorary*	*Patron*	*Total*
Resident	+41	+3	0	0	+44
Nonresident	−6	+4	−1	0	−3
Total	+35	+7	−1	0	+41

During the Academy year 1948 the Board of Managers held 10 meetings, with an average attendance of 19 persons. The following important matters were considered by the Board:

1. *Publication of a Monograph.* The monograph entitled *The parasitic cuckoos of Africa*, by HERBERT FRIEDMANN, was accepted for publication by the Board of Managers, and the Committee on Monographs was authorized to secure bids and arrange for its printing.

2. *Index to the Journal.* One of the recommendations made by a committee appointed last year to "Consider Various Matters Pertaining to the Journal and its Improvement" was that the Academy publish an index to the first 40 volumes of the JOURNAL. This year a committee was appointed to further investigate the matter of an index. They looked into costs of compilatioı , means of publication, and prospective sale, reporting their finds to the Board. The Board decided to go ahead with the preparation of copy, allowing a period of three years for its compilation, but deferred the matter of its publication until some future time, looking forward to the possibility of an outside grant to cover part or all of its publication cost.

3. *Changes in the Bylaws.* The Board of Managers recommended and the membership of the Academy approved three changes in the Bylaws: (1) The permitted number of regular members was increased 100, allowing a total of 750 for both resident and nonresident. The permitted number of resident regular members was increased to 600. (2) The office of President-elect was created to promote continuity of policies

and objectives of the Academy by acquainting the incoming president with the current business and the administrative routine of the Academy. (3) A new Article I was written to incorporate into the Bylaws a statement of purposes and objectives not previously included.

4. *New Standing Committees.* The Standing Rules for the Board of Managers were amended to provide for and define the activities of 4 new Standing Committees. Two of these, the Committee on Awards for Scientific Achievement and the Committee on Grants-in-Aid for Research, had been activated by the Board of Managers some years earlier but had not been defined by the Standing Rules. The two new committees created during the past year are the Committee on Policy and Planning and the Committee on the Encouragement of Science Talent. The Committee on Policy and Planning was activated for the purpose of periodically assessing the status of the Academy from a point of view of long-term objectives and recommending to the Board any changes in policy or in long-range planning designed to make the Academy more effective in the scientific life of Washington. The Committee on the Encouragement of Science Talent was created to give consideration to, and make arrangements for, participation of the Washington Academy of Sciences in activities promoting a professional interest in science among people of high school and college age.

During the Academy year, nine meetings of the Academy were held as follows:

On February 19, 1948, the 50th Anniversary Meeting was given over to a smoker with light refreshments.

On March 18, 1948, the 1947 Academy Awards were presented to HARRY W. WELLS, Department of Terrestrial Magnetism, Carnegie Institution of Washington, for work in engineering sciences; and to ROBERT D. HUNTOON, National Bureau of Standards, for work in the physical sciences. The subcommittee for the biological sciences failed to recommend an awardee.

On April 15, 1948, PHILIPP FRANK, Harvard University, addressed the Academy on *Philosophical interpretations of physical theories.*

On May 20, 1948, EDWARD U. CONDON, National Bureau of Standards, addressed the Academy on *Science and security.*

On October 21, 1948, substituting for MERRIAM H. TRYTTEN, ALEXANDER WETMORE, Smithsonian Institution, spoke to the Academy on the work of the Interdepartmental Committee on Scientific Research and Development; C. J. LAPP, Office of Scientific Personnel, spoke on *Baccalaureate origins of doctorates in scientific work;* and B. D. VAN EVERA, George Washington University, spoke on the fellowship program of the National Research Council.

On November 18, 1948, ROBERT F. BACHER, Atomic Energy Commission, addressed the Academy on *Research and development of atomic energy.*

On December 16, 1948, the meeting was devoted to a symposium on cancer research: ROSCOE R. SPENCER, National Cancer Institute, spoke on *Causes;* HAROLD F. DORN, National Cancer Institute, spoke on *Incidence and distribution;* and WALTER S. HARRISON, U. S. Naval Hospital, spoke on *Detection and treatment.*

On January 3, 1949, HANS CLOOS, University of Bonn, Germany, addressed a joint meeting of the Academy and the Geological Society of Washington on *Geologic structures through the ages.*

On January 22, 1949, W. ALBERT NOYES, University of Rochester, gave an after-dinner talk to the Academy on *International cooperation in science.*

All meetings, except that of January 3, were held in the Assembly Hall of the Cosmos Club. The Joint Meeting with the Geological Society of Washington on January 3 was held in the Department of the Interior Auditorium.

C. L. GAZIN, *Secretary.*

REPORT OF THE TREASURER

The Treasurer submits the following report concerning the finances of the Washington Academy of Sciences for the year ended December 31, 1948.

RECEIPTS

Dues,	1942	$5.00	
	1943	10.00	
	1944	15.00	
	1945	30.00	
	1946	60.00	
	1947	142.00	
	1948	3,405.75	
	1949	59.00	$3,726.75
Journal, Subscriptions,	1947	30.19	
	1948	798.48	
	1949	602.82	
	1950	10.13	1,441.62

Reprints,	1947.....	229.03	
	1948.....	587.35	816.38
Sales,	1948.....		176.90
Interest & Dividends, 1948.....			968.50
Directory, 33d edition.....			98.60
Science Calendar.....			40.00
Total receipts, 1948.....			$7,268.75
Cash balance, Jan. 1, 1948.....			4,343.50
Total to be accounted for.....			$11,612.25

DISBURSEMENTS

	1947	1948	Total
Secretary's Office..	$161.96	$341.62	$503.58
Treasurer's Office..		247.01	247.01
Subscr. Mgr. & Custodian.....		45.86	45.86
Meetings Committee.....	221.18	449.35	670.53
Membership Committee.....		7.89	7.89
Journal			
Printing & mailing.....	379.87	3,520.28	3,900.15
Illustrations.....	16.51	442.82	459.33
Reprints.....	73.76	439.79	513.55
Office			
Editorial Asst..	25.00	275.00	300.00
Miscellaneous..	9.23	33.12	42.35
Directory—33d edition.....		3,234.55	3,234.55
Miscellaneous:			
Debit Memos (A. S. & T. Co.)..$19.06			
Refunds Dues.... 5.00			
Refunds Photos.:. 10.00			
Science Calendar..... 62.10			
Back numbers of Journal.. 21.85		118.01	118.01
	$887.51	$9,155.30	$10,042.81
Cash book balance, December 31, 1948.			1,569.44
Total accounted for.....			$11,612.25

RECONCILIATION OF BANK BALANCE

Balance as per cash book, Dec. 31, 1948.		$1,569.44
Balance as per Am. Sec. & Trust Co. Statement of Dec. 1, 1948.....	$1,517.09	
Receipts undeposited, Dec. 31, 1948.....	371.38	
Total.....	$1,888.47	

Checks outstanding, as of Dec. 31, 1948

No. 1018.....	$5.41		
1263.....	5.00		
1269.....	28.57		
1270.....	50.00		
1271.....	41.95		
1272.....	171.35		
1273.....	16.75	319.03	$1,569.44

INVESTMENTS

Washington Sanitary Improvement Company

Certificate No. A 182—818 shares at $10.....	$8,180.00	
Note: Replaces Certificates Nos. 434, 435, 527, 539, and 582 totaling 409 shares, surrendered prior to issuance of new stock, June 21, 1948.....		$8,180.00

Potomac Electric Power Company

Certificate No. TAO 1977—40 shares 3.6% pref. at $50.00.....		2,000.00

City of New York—3% (Transit Unification) Due June 1, 1980

Certificate No:		
D 20186.....	$500.00	
C 71038.....	100.00	
C 71039.....	100.00	
C 71040.....	100.00	800.00

First Federal Savings & Loan Ass'n

Investment account book.....		5,000.00

Northwestern Fed. Savings & Loan Ass'n

Certificate No.:		
1380.....	4,500.00	
1441.....	500.00	5,000.00

United States Government

Series G. Bonds:		
No. M 332990 G.....	$1,000.00	
M 332991 G.....	1,000.00	
M 332992 G.....	1,000.00	
M 332993 G.....	1,000.00	
M 1808741 G.....	1,000.00	
M 2226088 G.....	1,000.00	
M 2982748 G.....	1,000.00	
M 4126041 G.....	1,000.00	
M 5141346 G.....	1,000.00	
M 5141347 G.....	1,000.00	$10,000.00

American Security and Trust Co.	
Savings Account	46.87
Total	$31,026.87
Cash balance Dec. 31, 1948	$1,569.44
Total	$32,596.31
Total as of Dec. 31, 1947	$31,280.37
Total as of Dec. 31, 1948	32,596.31
	$1,315.94

NOTE: This apparently anomalous situation to wit: An increase of $1,315.94 in total amount of invested funds, despite a heavy excess of expenditures over receipts during the year results from the "two for one" stock dividend declared during the year by the Washington Sanitary Improvement Co. and may be thus reconciled:

Increase in invested funds as shown in this report	$1,315.94
Excess of expenditures over receipts for 1948	2,774.06
Increase in book value of stock of Wash. San. Imp. Co.	$4,090.00

At the close of business on December 31, 1948, there were 38 members of the Academy who were in arrears, 26 for 1 year, 10 for 2 years, and 2 for 3 years.

HOWARD S. RAPPLEYE, *Treasurer.*

REPORT OF AUDITING COMMITTEE

The accounts of the Treasurer of the Washington Academy of Sciences for the year 1948 were examined by your auditing committee on January 11, 1949.

The attached copy of the treasurer's report was checked and found to be in complete agreement with the records, and with the cash balance of the Academy at the American Security & Trust Co. The bank deposits were found to check with the record of the receipts from all sources. All disbursements had been authorized and were found to be supported by vouchers and cancelled checks. The securities of the Society were inspected and found to be in agreement with the list given in the report and to have all coupons attached that are not yet due.

Your Auditing Committee highly commends the Treasurer upon the orderly and businesslike manner in which he has maintained the fiscal records of the Academy.

HAROLD F. STIMSON.
W. G. BROMBACHER.

REPORT OF THE BOARD OF EDITORS

Volume 38 of the JOURNAL, for the year 1948, contained 425 pages, a loss of about 23 pages as compared with the previous year. There were 47 papers in biology, 13 in the physical sciences, and 11 in other subjects of an interesting nature, making 71 in all. The biological sciences accounted for slightly less than half the number of pages, and the physical sciences for slightly more than one fourth. This represents a large increase in the percentage of pages in the physical sciences over 1947, which was to be expected with a chemist as Senior Editor.

A deluge of price increases in all phases of printing resulted in costs running far above those of the previous year. The disbursements for the JOURNAL during 1948 were:

Printing and mailing	$4,950.22
Illustrations	569.87
Reprints	665.07
Office—Editorial Assistant	300.00
Office—Miscellaneous	35.20
Total	$6,520.36
Charge to authors	918.17
Net cost of the Journal to the Academy	$5,602.19

In 1947, the net cost to the Academy was $3,901.35.

Early in the year the George Banta Publishing Co. notified the Senior Editor that they intended to discontinue printing the JOURNAL about September 1. This action threatened to leave us without a printer for a part of the year, but, through the intercession of Mr. Irwin Wensink, Banta was persuaded to finish the year. Considerable difficulty was at first encountered in interesting publishing houses in printing the JOURNAL, but late in the year three printers became quite anxious to obtain the contract because it would most likely provide a steady income over a long period of years, thereby offering security during dull business periods.

The contract was finally given to Waverly Press of Baltimore, partly because their charge for printing the JOURNAL was quite reasonable and to a greater extent because their charge for reprints was considerably below that of any other printer. This is an item that could not be overlooked because inexpensive reprints should be available to authors who so liberally give their time and energy in order that we may have an Academy publication on a high plane. Special

thanks are due Mr. Irwin Wensink, Washington representative of the George Banta Publishing Co., for his help in evaluating the bids for printing the JOURNAL and thereby helping the Board of Editors to choose a satisfactory printer.

The Board of Editors acknowledges the cooperation of the Board of Managers and the officers of the Academy during the trying times of the past year. Special thanks are due Mr. PAUL H. OEHSER, the Editorial Assistant, who so ably handles the technical side of printing the JOURNAL. Without his services the work of the Board of Editors would be exceedingly difficult.

The high cost of printing the JOURNAL has been a cause of considerable worry to us, but we are convinced that the high quality of the papers and of the JOURNAL during 1948 was well worth the price.

JAMES I. HOFFMAN.
ALAN STONE
FRANK C. KRACEK.

REPORT OF THE CUSTODIAN AND SUBSCRIPTION MANAGER OF PUBLICATIONS

It will be noticed, on comparison with the figures of reserve sets given in the previous Annual Report (for 1947), that though the number of volumes set aside for reserve sets has been changed slightly from that first specified by the Board of Managers in 1939, the total number of current volumes set aside each year is the same—25.

Subscriptions

Nonmember subscriptions in the United States	131
Nonmember subscriptions in foreign countries	72
Total	203

Inventory of Stock as of December 31, 1948

Reserve sets of the Journal

Complete sets, vols. 1–38	5 sets
Volumes 11–38	6 sets
" 16–38	9 sets
" 21–38	5 sets
Total reserve sets more or less complete	25 sets

Back numbers of the Journal

Numbers in complete sets (5)	3,195
Numbers held in reserve for complete sets	7,783
Numbers available for sale separately	17,495
Total back numbers on hand	28,473

Proceedings

Complete sets, volumes 1–13 (1899–1911)	49 sets

(The copies of the separate articles in the Proceedings have not been counted.)

Sales and Expenditures

During the year no complete sets of the JOURNAL were sold, but 195 separate numbers were sold to various individuals and organizations in this country, Hawaii, Canada, Colombia, Venezuela, Great Britain, Denmark, Sweden, France, Hungary, New Zealand, and China. One complete set of the Proceedings was sold, as were five individual papers from the Proceedings.

427 odd numbers from volumes 1–22 of the JOURNAL were purchased from a second-hand bookdealer for $20. This not only gave us copies of many scarce issues of the early volumes, but enabled us to make up another complete set of the JOURNAL, increasing the number of these sets from four to five. Members of the Academy have continued to generously donate unneeded copies to this office. We are still very desirous of obtaining copies of numbers of the earlier volumes.

Income from Sales

Miscellaneous numbers	$176.90

Expenditures

Purchase of 427 numbers (vols. 1–22)		$21.85*
Postage and office expenses		
Stationary	18.91	
Postage	5.92	
Clerical assistance	5.00	
		29.83
Project for increasing subscription list		
100 postcards	1.00	
100 large envelopes	2.15	
100 3-cent stamps	3.00	
100 extra copies of April 1948 issue	6.66	
100 copies of 1947 index	13.50	
100 copies of circular letter		
Printing 100 self-addressed postcards	4.50	
		30.81
Total expenditures		$60.64
Budget allowance		50.00
Deficiency		10.64

*Deductible from special fund earmarked for purchase of volumes and numbers necessary to complete sets. The present balance in this fund is $89.65.

Campaign for Increasing Subscription List

Early in 1948 the Executive Committee of the Academy asked the Custodian and Subscription Manager of Publications to undertake to increase the number of subscribers to the JOURNAL, and outlined certain proposals for carrying on this campaign. For various reasons this project was not started until late in the year. At that time 100 circular letters were mailed to 100 carefully selected libraries who were not subscribers but who it was felt might be interested in the Journal. A sample number of the JOURNAL was enclosed as well as a copy of the 1947 index, and a self-addressed postcard. To date 4 replies have been received. One represents a new subscription, and two cases are being pursued further, and may result in subscriptions. It is expected that further cards will be returned, and it is hoped that a substantial addition may be made to our list of nonmember subscribers.

Storage of Stock

With the cancellation of the long-standing contract with the George Banta Publishing Co. the question of storing the stock now held in Menasha, Wis., must be considered. An examination of the room in the Smithsonian Institution in which part of the stock is now housed, through the generous cooperation of the officers of that institution, shows, I believe, that with some rearrangement most, if not all, of the material now at Menasha can be stored here. The Academy has been offered further space to house the copies of the Academy's first monograph, by HERBERT FRIEDMANN.

HARALD A. REHDER, *Custodian and Subscription Manager of Publications.*

REPORT OF THE COMMITTEE OF TELLERS

A total of 293 envelopes were delivered to the Secretary. The count of valid ballots showed the following officers were elected:

President—FRANK H. H. ROBERTS, Jr.
President-Elect—FRANCIS B. SILSBEE
Secretary—FRANK M. SETZLER
Treasurer—HOWARD S. RAPPLEYE
Board of Managers, to January 1952—WILLIAM F. FOSHAG, C. LEWIS GAZIN

JOHN W. MCBURNEY, *Chairman.*
ROGER G. BATES
WILLIAM A. WILDHACK.

REPORT OF THE SPECIAL COMMITTEE ON AN INDEX FOR THE JOURNAL

The need of an adequate index to the nearly 40 volumes of the JOURNAL of the Washington Academy of Sciences has been a matter of growing concern to the Board of Editors and the despair of reference librarians. In fact, the first recommendation of a Committee on the JOURNAL, which reported at the January meeting of the Board of Managers, states: "That an index of the Journal be prepared and published for the first 40 volumes and for each succeeding 10 volumes" (vol. **38:** 79). This matter again came up before the Board of Managers on March 15, when the Editor recommended that the project be prosecuted by the Committee on Monographs, and the President was then authorized to appoint a committee to consider the index and to make recommendations (p. 189).

The Committee was already at work when it received its mandate late in March. It consisted of the Editor and two past editors, two members whose profession is editing, and, by invitation, Mrs. Mabel H. Doyle, chief indexer of the Department of Agriculture. We were to investigate how such an index should be prepared, who should do it, and make some suggestions on means of doing it. After due consideration of what is ideal and what the Academy might afford, the Committee made these findings: (1) that the index be a combined author-subject index; a complete analytical index was abandoned as too expensive; (2) that the work be done by a professional indexer to be found by the Committee; (3) that $1,500 as a minimum ought to be set aside for the preparation of copy, and estimates were secured of printing; (4) that the probable sale is limited to libraries, since members of the Academy will expect to receive copies; and (5) it seemed likely that a subvention might be required and successfully solicited to publish it. Such was the report made to the Board of Managers in May.

The matter having been referred to the Executive Committee, the latter body, meeting May 26, voted to recommend to the Board that it authorize, for the necessary expenses of preparing the manuscript, including the materials, a sum not to exceed $2,000, commencing in 1949 (p. 282). The Board gave its sanction June 7.

This success was quite unexpected, but over the summer the Committee regained its initiative.

After conferring with the Treasurer to ascertain that the funds would be available come January 1, 1949, the chairman convened the group again on October 5 to set the project in motion. Again we met in the office of Dr. Merrill, Department of Agriculture, and once more we had the advice of Mrs. Doyle through whom we secured the interest of Miss Mary A. Bradley. Having enlisted the cooperation of the person who was our first choice to do the work, our troubles were over. It was agreed that one member, Mr. Oehser, would prepare a set of directions for the indexing, and that he would also act as liaison for the Academy and the Committee on matters of policy. The chairman would draw up a contract. A list of subject matter specialists would be furnished. Miss Bradley would index one volume, and then in consultation with the Chairman and Mr. Oehser, would submit an estimate for the entire job.

Having duly reported these transactions to the Board of Managers, the Chairman was authorized to proceed on the basis outlined and to negotiate a contract. In a letter from Miss Bradley to the Chairman, dated November 1, 1948, was received an estimate of $1,500 for preparing and editing a cumulative author-title index to volumes 1 through 40 of the Journal. This estimate was understood to include the preparation and editing of the index in card form, marking the cards for the printer, reading the galley and page proof, and settling problems as they arise until the index is printed, keeping in close touch with the Committee during the work. With the authorization of the Board of Managers, this estimate was accepted November 18; and it was stated as understood that a list of specifications, to be drawn up by Miss Bradley and Mr. Oehser, should be considered as part of the agreement. Accordingly, a contract was prepared in consultation and signed January 5, 1949 by Miss Bradley and the Chairman for the Committee.

One item in the specifications requires comment. Since the certainty of printing the index awaits the further pleasure of the Board of Managers and printing may rest on the possibility of securing a subvention from an outside source, Miss Bradley is held to seeing the proof through the printer only if the Academy forwards the printing within 18 months from the time the index is completed. This is a reasonable request, in the estimation of the Committee. The Index will make an appropriate addition to the Monographs series and might be published with funds appropriated to that purpose.

In addition to the preceding negotiations, which constituted the main work of the Committee, it is a pleasure to report, in conclusion, that work on the index is progressing; one volume is in the hands of the Committee at this time.

JAMES I. HOFFMAN
M. C. MERRILL
PAUL H. OEHSER
H. A. REHDER
WM. N. FENTON, *Chairman.*

Submitted by C. LEWIS GAZIN, *Secretary.*

427TH MEETING OF BOARD OF MANAGERS

The 427th meeting of the Board of Managers, held in the Cosmos Club on April 18, 1949, was called to order at 8:00 P.M., by the President, F. H. H. ROBERTS, Jr. Present were: F. B. SILSBEE, H. S. RAPPLEYE, N. R. SMITH, F. G. BRICKWEDDE, W. W. DIEHL, F. M. DEFANDORF, C. L. GAZIN, F. E. JOHNSTON, J. W. ALDRICH, F. D. ROSSINI, F. A. WEISS, W. A. DAYTON, MARGARET PITTMAN, and F. M. SETZLER.

The President indicated an excellent response to the 364th meeting of the Academy, which was held jointly with the Biological and Entomological Societies of Washington on April 15, 1949, at which Dr. Karl von Frisch, of the University of Graz, Austria, gave an illustrated address on *The language of bees.* Approximately 500 people attended the lecture in the auditorium of the U. S. National Museum.

The President read a memorandum from the Chairman of the Policy and Planning Committee in response to a letter from the American Documentation Institute. The Chairman of the Committee recommended that the Academy should not undertake any additional financial commitments at the present time. The Board approved the recommendation of the Committee.

The President also reported the Academy's activities with regard to the Science Fair, in which 605 high-school students presented exhibits of their work and from whom 48 winners were selected. Twenty out of the 48 winners have been selected by the Franklin Institute to bring their exhibits to Philadelphia on April 23, 1949, as guests of the Institute.

Eleven persons nominated for resident membership and one for nonresident membership at

the 426th meeting of the Board of Managers were elected.

HENRY W. BEARCE and WILLLIAM F. ALLEN, having retired from the gainful practice of their professions were transferred to the retired list of membership, effective December 31, 1948.

The Secretary reported the deaths of the following members: CARL F. A. CHRISTENSEN, Universititets Botaniske Museum, Copenhagen, Denmark, on November 24, 1942 (honorary member; elected January 15, 1923); SAMUEL F. HILDEBRAND, Fish and Wildlife Service, on March 16, 1949 (elected December 1, 1939); GEORGE B. RICHARDSON, U. S. Geological Survey, on March 18, 1949 (elected May 14, 1928; on retired list 1943); WILLIAM B. BELL, retired, formerly Fish and Wildlife Service, on March 30, 1949 (elected June 3, 1932); JOSEPH A. CUSHMAN, Cushman Laboratory for Foraminiferal Research, Sharon, Mass., on April 16, 1948 (elected March 25, 1918).

The Treasurer indicated that the statement covering the cost of publication of the first monograph, *The parasitic cuckoos of Africa*, had been received and paid.

The meeting was adjourned at 8:45 P.M.

F. M. SETZLER, *Secretary.*

Obituaries

ERNEST CLAYTON ANDREWS, for 25 years an honorary member of the Washington Academy of Science, died on July 1, 1948. Born at Balmain, an inner suburb of Sydney, New South Wales, on October 18, 1870, of English parents, Andrews received his early education at a local denominational school conducted by the Wesleyan Church where his father, John Andrews, was the sole teacher. His home and school life was conditioned in an atmosphere of strict religious observance with a profound Puritanical strain which discouraged study of the arts and sciences and enjoined attention upon practical matters. Nevertheless the boy, by surreptitious and devious means, became an omnivorous reader of the classics and acquired a deep love for literature and poetic expression. He obtained a scholarship to the Teachers' Training College and entered that institution in January 1891, matriculated in March the same year, enrolled at Sydney University, and graduated bachelor of arts in 1894, specializing in mathematics and geology. While on the teaching staff of the Bathurst Public School he explored the countryside, and arising from his observations came his first paper on geology, presented at the meeting of the Australasian Association for the Advancement of Science held in Sydney in January 1898.

Andrews was nominated in 1898 to undertake the collection of coral reef material in Fiji. He obtained leave of absence from the education department and spent six months in Fiji and Tonga, an experience which he described as "invigorating and helpful." His report on the Fiji trip with a preface by Prof. T. W. Edgeworth David was published in the Bulletin of the Museum of Comparative Zoology, Harvard.

Having obtained permission to attend university courses in geology and chemistry, Andrews was successful in a competitive examination for the position of geologist in the Geological Survey of New South Wales. He was appointed on July 1, 1899, and remained in the Survey until his retirement on December 4, 1931, attaining the top rank of government geologist in January 1920.

In his official post he acquired an unrivaled knowledge of the geology of the State of New South Wales. His investigations were concerned essentially with the economic aspect of the science as applied to problems affecting the major mining fields. Among his many reports published by the Department of Mines the most noteworthy contribution was his epic memoir on Broken Hill issued in 1922, which covered the results of five years of field study and enunciated the basic structural and genetic features of the famous ore bodies so clearly and soundly that his interpretation is acknowledged to have stood the test of subsequent developments and to have been confirmed in principle by a wealth of more detailed surveys since made. He may rightly be regarded as the pioneer Australian geologist in the field of structural economic geology as applied to the study of ore bodies.

His official duties did not deter him from making valuable contributions in other branches of science, especially in physiography, in which

he was inspired by the work of W. M. Davis. Notwithstanding adverse criticism he persevered in his originality and contributed many important papers on this subject, of which particular mention may be made of two, viz., *Corrasion by gravity streams* and *The geographical unity of eastern Australia in Tertiary and post-Tertiary times*. He also wrote a number of papers on a variety of structural problems and became particularly interested in such broad concepts as the origin of mountains, stabilization of the continents, and the structural unity of eastern Australia. He was prompted to prepare a manuscript entitled *The plan of the earth*, which he forwarded to the Geological Society of American in 1944 for consideration.

Examinations of the Great Barrier Reef and of coral reefs in New Caledonia and the New Hebrides, as well as his presidential address to the Royal Society of New South Wales in 1922 entitled *Origin of coral reefs in Pleistocene and Recent time*, were evidence of his sustained interest in the subject engendered by his original experiences in Fiji and Tonga.

In 1908 he visited the Sierra Nevada of California and was enabled to continue the studies in ice action which he had begun in New Zealand. During this visit he made the first ascent of Mount Darwin.

Brilliant though he was as a geologist, Andrews won equal renown as a botanist. He became especially interested in the Myrtaceae and Leguminosae, contributing papers on the origin and distribution of both groups as well as a notable paper on the geological history of the Australian flowering plants. In many instances he made practical use of his knowledge of the habitats of the native flora in mapping the boundaries of rock types in heavily timbered country.

In recognition of his scientific attainments many honors were bestowed upon him, notably the David Syme Prize and Medal from the University of Melbourne (1915), the Clarke Memorial Medal from the Royal Society of New South Wales (1928), the Lyell Medal from the Geological Society of London (1931), and the Mueller Memorial Medal from the Australian and New Zealand Association for the Advancement of Science (1946). In addition, he was invited to deliver the Silliman Lectures at Yale (1927) and the Clarke Memorial Lecture for the Royal Society of New South Wales (1942). He was elected an honorary member of the Washington Academy of Sciences on January 15, 1923.

Activities designed toward the advancement of science in Australia and the Pacific received his whole-hearted support, as is evidenced by his membership of the following bodies: Royal Society of New South Wales (president 1921); Linnean Society of New South Wales (president 1937); Australasian Association for the Advancement of Science (president 1930); Australian National Research Council; Australasian Institute of Mining and Metallurgy (president 1929). He was a delegate to the Second Empire Mining Congress, Canada, 1927, and attended the Pan Pacific Science Congresses held in Honolulu, Australia, Japan, Java, Canada, and United States, the three last-mentioned as leader of the Australian delegation.

In 1909 he married Florence May Byron, who died in 1923. In 1929 he married Mabel Agnes Smith, daughter of John H. Smith, First Unitarian Minister, Sydney.

He had an intense love of music and in later years devoted his attention to the philosophical and spiritual side of life, publishing two small books giving his views—*The increasing purpose* (1939) and *The eternal goodness* (1948).

Andrews not only enjoyed a very high reputation as a scientist but was held in the highest esteem by his colleagues and friends for his kindly nature, his unfailing courtesy, and his willingness at all times to advise and assist all who sought his wise counsel.

WILLIAM HARVEY EMMONS was born at Mexico, Mo., on February 1, 1876, and died at his home in Minneapolis on the evening of November 5, 1948, where he was still pushing forward his current research.

In 1897 when young Bill Emmons was through with his football days at Central College in his native State of Missouri, he plunged into graduate work in geology at the University of Chicago with the warmhearted zest and enthusiasm that always remained perhaps his most characteristic trait. His thesis area lay in the rugged mountains of southern Montana, and here he found the mental challenge and physical adventure that to him made geology the most fascinating pursuit in the world. Recalling this first field work in the thin air of the high mountains he said, "That's wonderful country! You sit down on a moun-

tain and feel like an angel!—until you get up." It was inevitable that as soon as he got his Ph.D. degree in 1904, he would join the U. S. Geological Survey to study the geologic hinterlands of the United States. His innate friendliness and genuinely democratic fondness for people, together with a keen mind and unbounded energy, made his work in the rough, tough mining camps a long series of happy, satisfying adventures.

Whether rushing into camp for a hurried shower before spending half the night with a local singing club, or miles away in the desert excitedly tracing a fault till darkness interfered, the husky young cub seemed to squeeze the joy of living out of every moment of each long day. His coworkers respectfully nicknamed him Bill "Horse" Emmons and—affectionately—"Wild Bill."

In 1907 he began to devote part of his time to lecturing at the University of Chicago, and in 1909 accepted a position as associate professor of petrology and economic geology. In 1910 he married Miss Virginia Cloyd.

At the University of Minnesota, where he was called to head the department of geology in 1911, he soon surrounded himself with a brilliant and harmonious group of teachers, destined to become internationally known for the excellence of both their teaching and research. He was a scholastic lodestone himself, and students at all levels of training flocked to his classes.

Dr. Emmons's great talent for teaching lay in his ever-broadening background of field experience, his amazingly detailed knowledge of the literature, an easy extemporaneous delivery, and, above all, in the contagion of his absorbed enthusiasm for his subject. One of his undergraduates once remarked, "He is the only professor I know who can climb on a desk to point out a place on the map, forget to get down for the rest of the hour, and not have the class think it funny."

Teaching took only a part of his long work day, however; there always seemed to be plenty of time for writing, research, consulting work, and for talking to students and visitors. Although he often worked 18 hours day after day when delving into some new and fascinating bit of research, and at such times might pass his closest friends without recognizing them, such intense preoccupation was only intermittent; between times he made the most of his social contacts, and whether playing with his children, Betty and Bill, or indulging in a bridge game at the Faculty Club his ringing laugh and humorous anecdotes enthralled his companions.

He took a boyish pleasure in earning the substantial fees that accompanied commercial work; but the problems, the travel to far places, were the primary attractions in this new theater of operations. The stock market crash of 1929–30 wiped out a large part of his investments, leaving him frankly bewildered but only momentarily downcast; his ebullient spirit and saving sense of humor carried him blithely through what others would have called disaster. After all, his satisfactions were in the production of such valuables at *The enrichment of ore deposits*, *Principals of economic geology*, *The geology of petroleum*, *Primary downward changes in ore deposits*, and *Gold deposits of the world*.

After a severe and protracted case of pneumonia when about 64, Dr. Emmons began to find his strenuous program of classwork and research much restricted by the need for rest. Retiring from "active work" in 1944 at the age of 68, he was nevertheless busily engaged in preparing a companion volume to *Gold deposits of the world* when he died. His genius for kindling others with the fire of enthusiasm was perhaps his greatest gift; and the contributions of literally hundreds of able geologists all over the world carry on the work, inspired by one of the great teachers of modern geology.

T. S. Lovering.